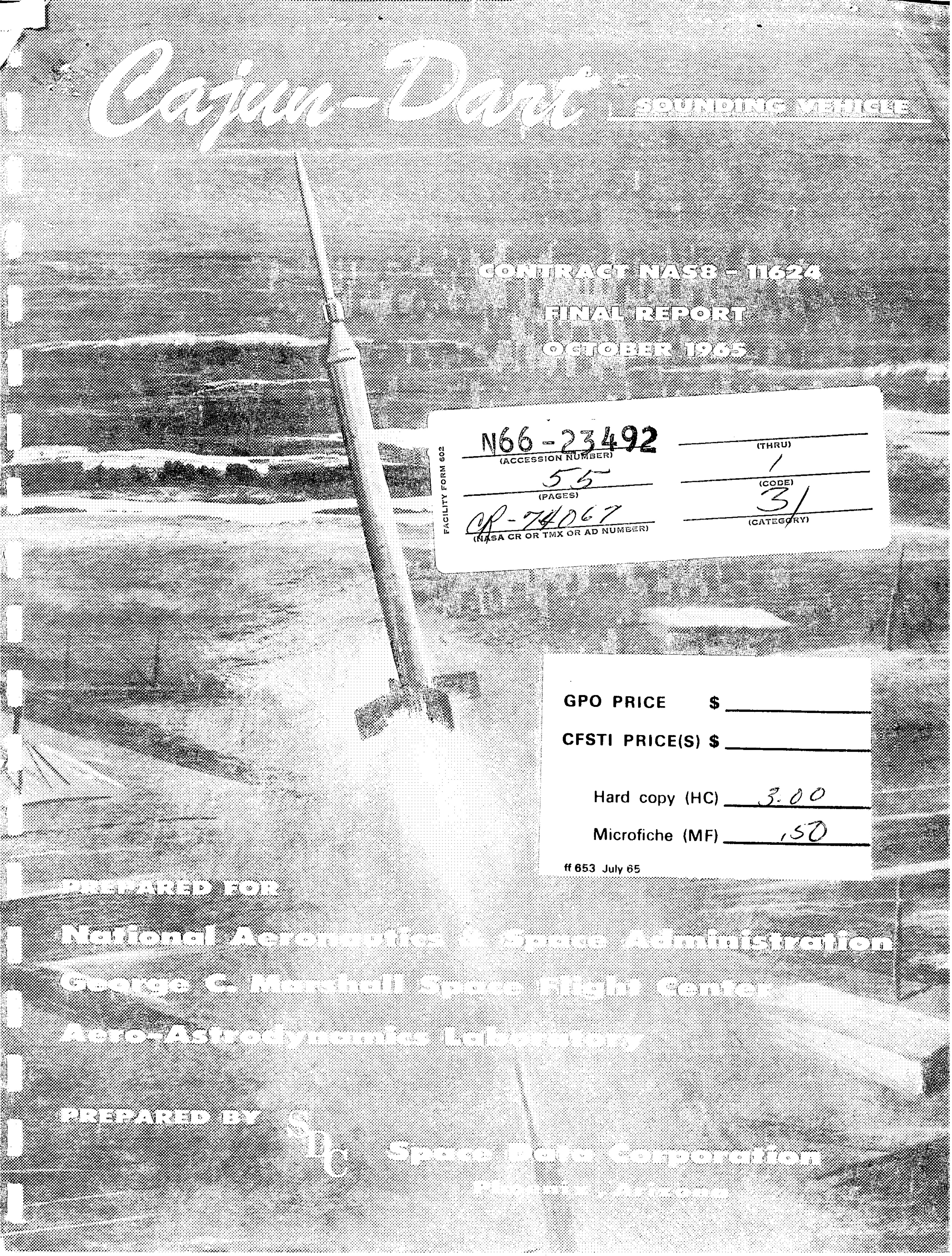


Cajun-Dart SOUNDING VEHICLE

CONTRACT NAS8 - 11624

FINAL REPORT

OCTOBER 1965

N66-23492 (ACCESSION NUMBER)

(THRU)

55 (PAGES)

1 (CODE)

CR-74067 (NASA CR OR TMX OR AD NUMBER)

31 (CATEGORY)

FACILITY FORM 602

GPO PRICE $ ______

CFSTI PRICE(S) $ ______

Hard copy (HC) 3.00

Microfiche (MF) .50

ff 653 July 65

PREPARED FOR

National Aeronautics & Space Administration

George C. Marshall Space Flight Center

Aero-Astrodynamics Laboratory

PREPARED BY

SDC Space Data Corporation

Phoenix, Arizona

CAJUN-DART

SOUNDING VEHICLE

SPACE DATA CORPORATION
1331 S. 26TH STREET
PHOENIX, ARIZONA

CONTRACT NO: NAS8-11624

FINAL REPORT

OCTOBER 1965

PREPARED FOR

NATIONAL AERONAUTICS & SPACE ADMINISTRATION

GEORGE C. MARSHALL SPACE FLIGHT CENTER

AERO-ASTRODYNAMICS LABORATORY

HUNTSVILLE, ALABAMA

TABLE OF CONTENTS

INTRODUCTION

TECHNICAL DISCUSSION

Vehicle Description
- Fig. 1 Drawing of Cajun Dart
- Fig. 2 Photograph of Cajun Dart Assembled
- Fig. 3 Photograph of Cajun Dart Dis-Assembled
- Fig. 4 Drawing of Dart
- Fig. 5 Photograph of Dart Assembled
- Fig. 6 Photograph of Dart Dis-Assembled

Vehicle Performance
- Fig. 7 Graph of Altitude Vs. Range
- Fig. 8 Graph of Altitude Vs. Time

Program Description
- Fig. 9 Vehicle On Launcher at Cape Kennedy
- Fig. 10 Vehicle On Launcher at Cape Kennedy

Table 1 Flight Results

APPENDIX A	Cajun Dart Range Safety Information SDC TM-40
APPENDIX B	Cajun Dart Assembly and Checkout Procedure
APPENDIX C	Reduced Winds From Eglin AFB Flights

INTRODUCTION

The Cajun Dart vehicle was developed by Space Data Corporation as a tool for studying upper atmospheric data in the region below 95 kilometers. The Cajun Dart was first manufactured and flight tested in May of 1964.

In February of 1964, the Aero-Astrodynamics Laboratory of George C. Marshall Space Flight Center solicited proposals for a rocket vehicle system to measure winds in the altitude range from 70 to 90 kilometers. The system subsequently selected was the Cajun Dart vehicle proposed by Space Data Corporation. The contract for 60 vehicle systems was awarded to Space Data Corporation in June of 1964.

Six flight tests were subsequently conducted at Eglin Air Force Base, Florida, under the NASA contract to demonstrate the Cajun Dart performance. Following these initial flights the remaining 54 vehicles were shipped to the Air Force Eastern Test Range, Cape Kennedy, and are being flown on a one (1) per week schedule. A total of thirty (30) Cajun Darts had been flown through July of 1965.

VEHICLE DESCRIPTION

The Cajun Dart chaff rocket is a two stage dart type sounding rocket vehicle. In the launch configuration the vehicle has a gross weight of about 200 pounds and an overall length of 13 feet. Figure 1 shows the vehicle with the basic dimensions and weights. Figure 2 is a photograph of the entire vehicle system, and Figure 3 shows the vehicle separated into its 2 major components, the Cajun first stage booster, and Dart second stage. The first stage of the Cajun Dart is the Cajun rocket motor, Mod III, manufactured by Thiokol Chemical Corporation, Elkton, Maryland. The Cajun motor is 102 inches long and has a principle diameter of 6.5 inches. The motor less flight hardware weighs 168 pounds with 118.5 pounds of propellent. The nominal burning time of 2.8 seconds, with a total impulse of 25,250 pound seconds, yields a burnout velocity of slightly over 5000 feet per second at an altitude of 7,000 feet. At Cajun burnout, separation of the Dart from the Cajun booster is accomplished by allowing the aerodynamic drag differential between the booster and Dart to physically separate the two (2) stages. After separation the Dart continues to coast to payload ejection.

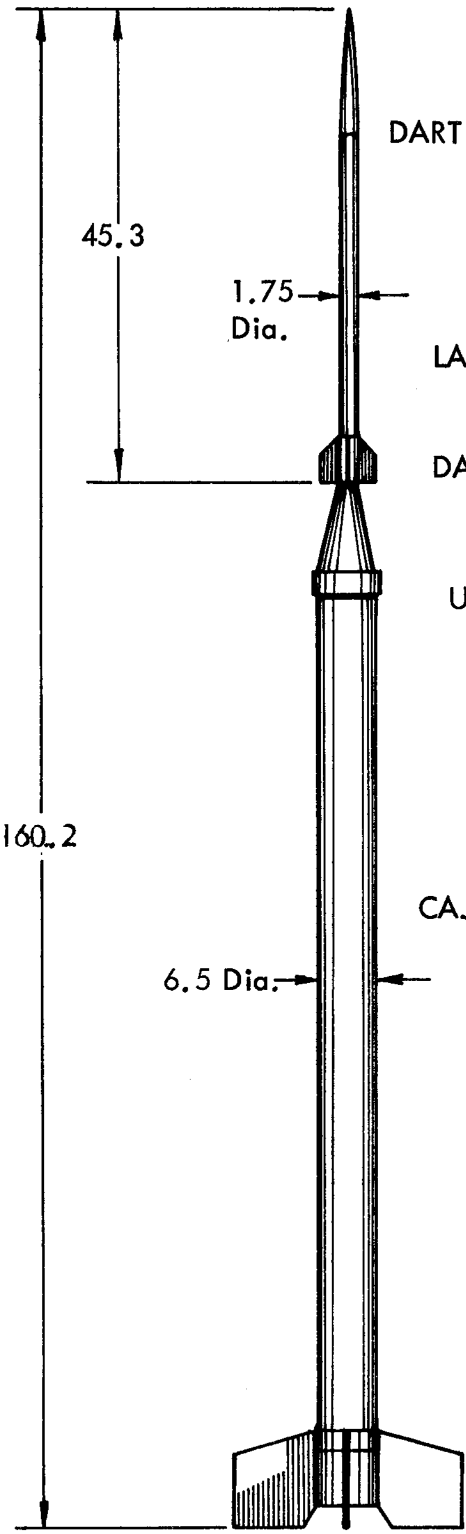
The Dart is 1-3/4 inches in diameter, weighs 17 pounds and is 51.7 inches long. The Dart is a nonthrusting stage functioning only as a low drag payload housing. The nose of the Dart is designed to have a hypersonic optimum shape, keeping the aerodynamic drag to a minimum. The aft end of the Dart has been boat tailed forming the interstaging surfaces as well as reducing the base drag. These two (2) factors along with the otherwise sleek shape of the Dart combine to produce a very low drag rocket configuration. The payload housed inside the Dart is 30 cubic inches of 5 mil, aluminized mylar, foil chaff cut to S band length.

Figure 4 is a cutaway drawing of the Dart showing the external dimensions as well as the internal configuration. Figure 5 is a photograph of the Dart and Figure 6 is a photograph of the Dart in a disassembled condition.

In order to make a system to reliably measure winds from 90 kilometers down, the nominal vehicle apogee must be above this altitude. As shown in Figures 7 and 8 the nominal apogee point for the Cajun Dart is 93 kilometers altitude, 37 kilometers range, at a time of 140 seconds, when fired at an 80 degree elevation angle. This will keep the apogee of all flights above 90 kilometers even with the normal vehicle dispersion.

When the Dart has reached its apogee, the payload is ejected. This expulsion is accomplished by the use of a 145 second pyrotechnic time delay housed in the Dart tail and initiated at launch. At 145 seconds the time delay ignites a 5 gram expulsion charge which ejects the Dart nose cone and the chaff payload by forcing a piston the full length of the Dart. The chaff is then free to drift with the winds as it falls.

SPACE DATA CORPORATION
PHOENIX, ARIZONA



CAJUN DART SOUNDING VEHICLE FIG. 1

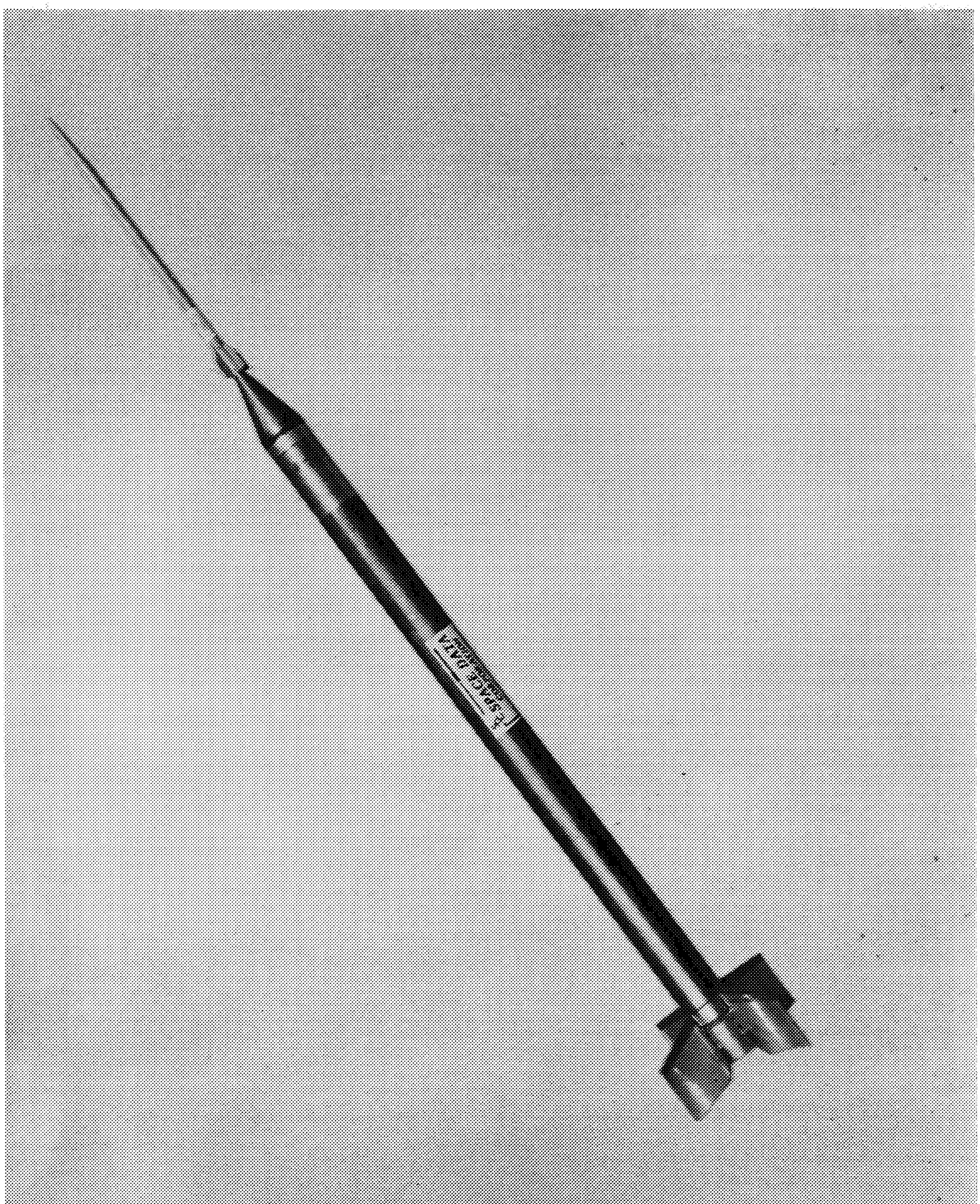


FIGURE 2
CAJUN DART ASSEMBLY

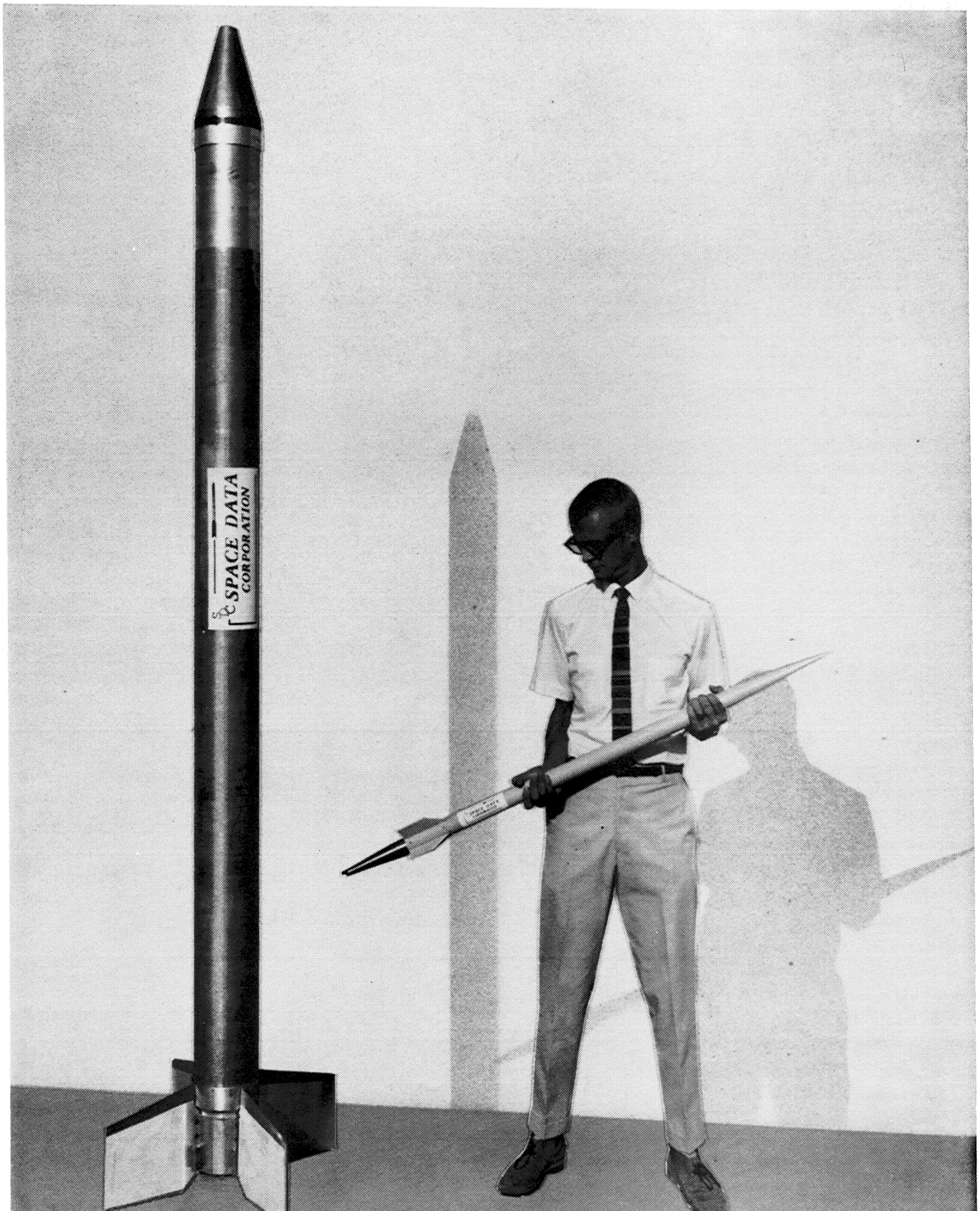


FIGURE 3

MOTOR & DART

SPACE DATA CORPORATION

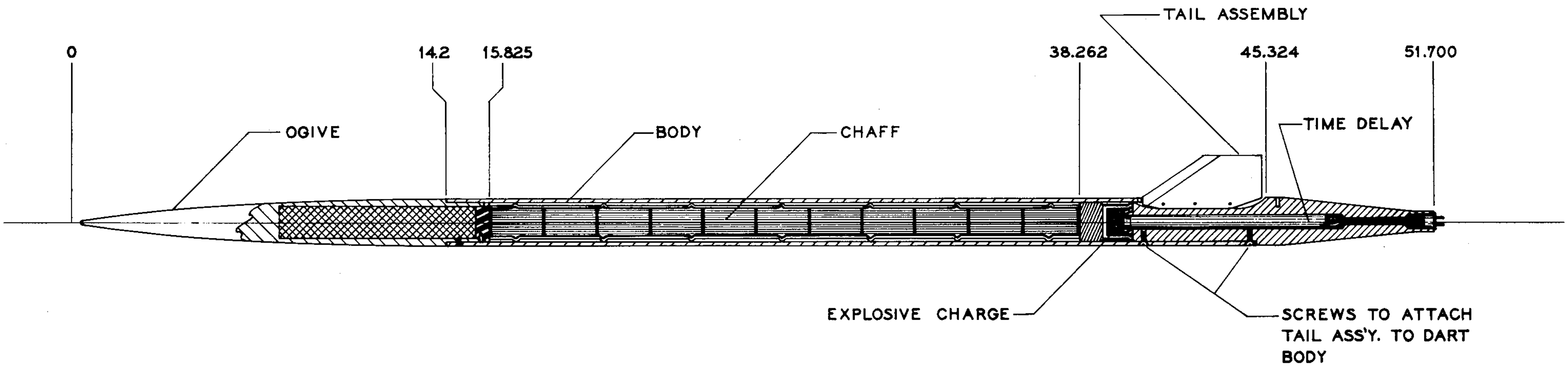


FIG. 4

CAJUN DART ASSEMBLY

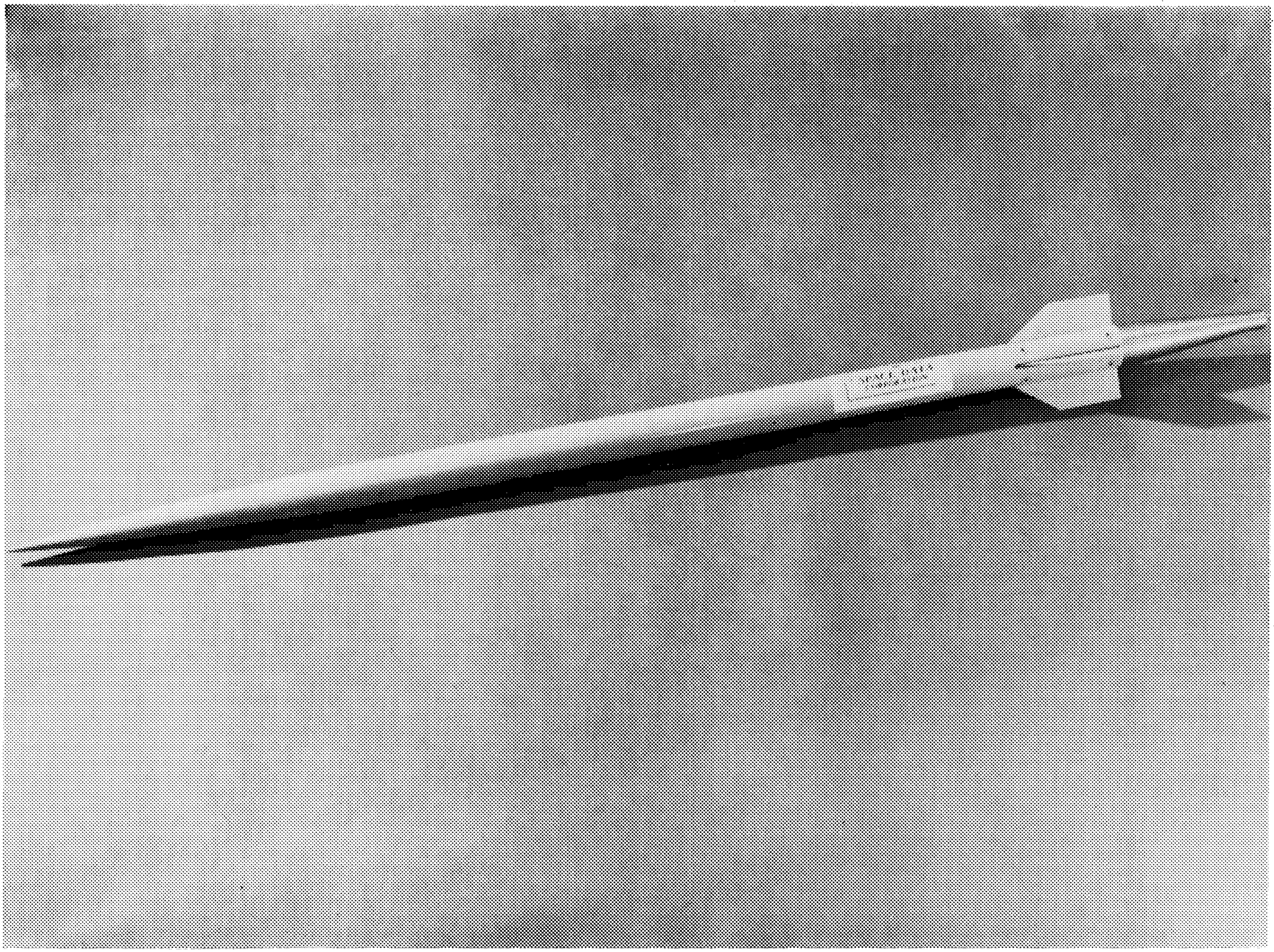


FIGURE 5
ASSEMBLED DART

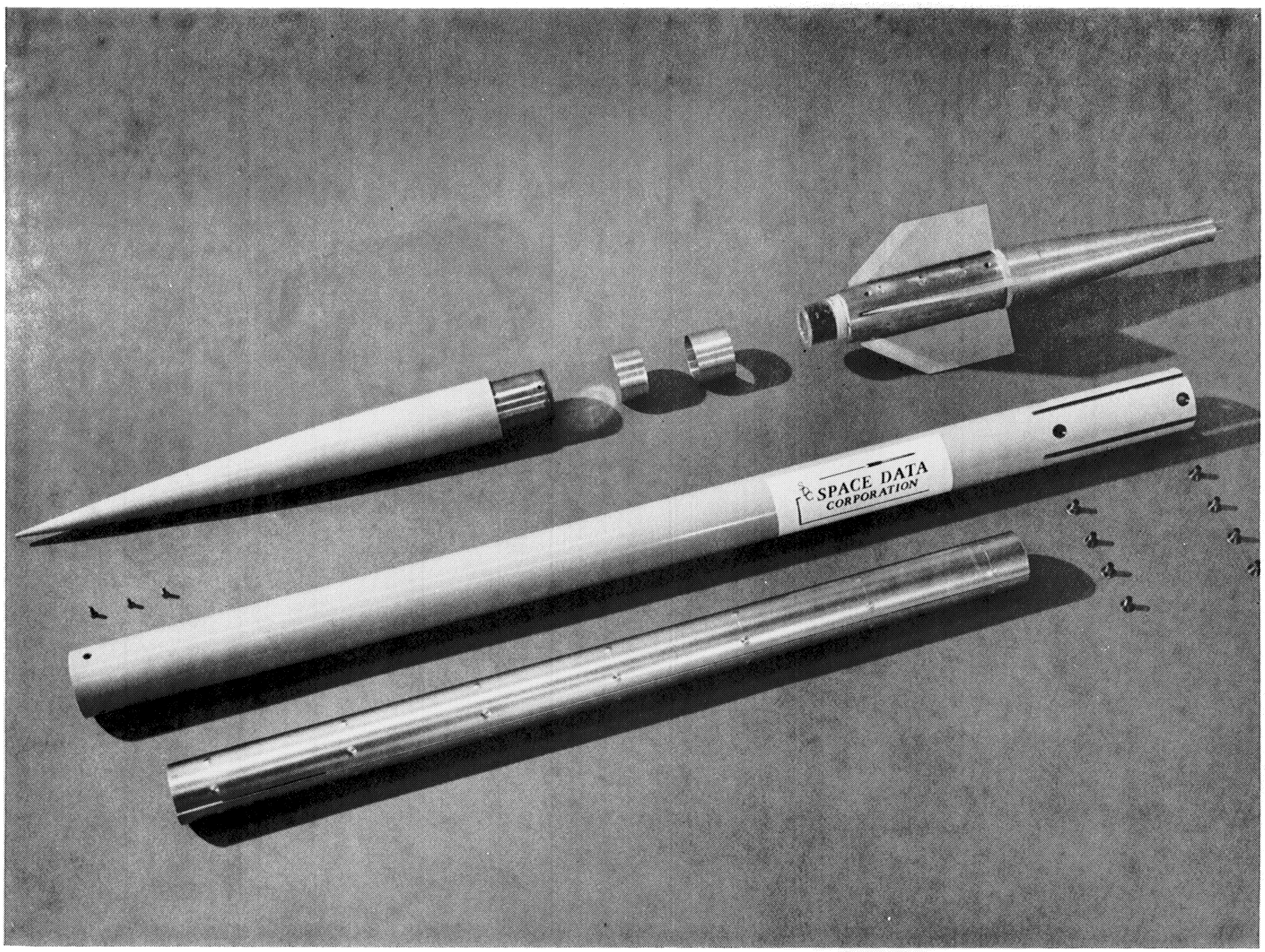


FIGURE 6
DART COMPONENTS

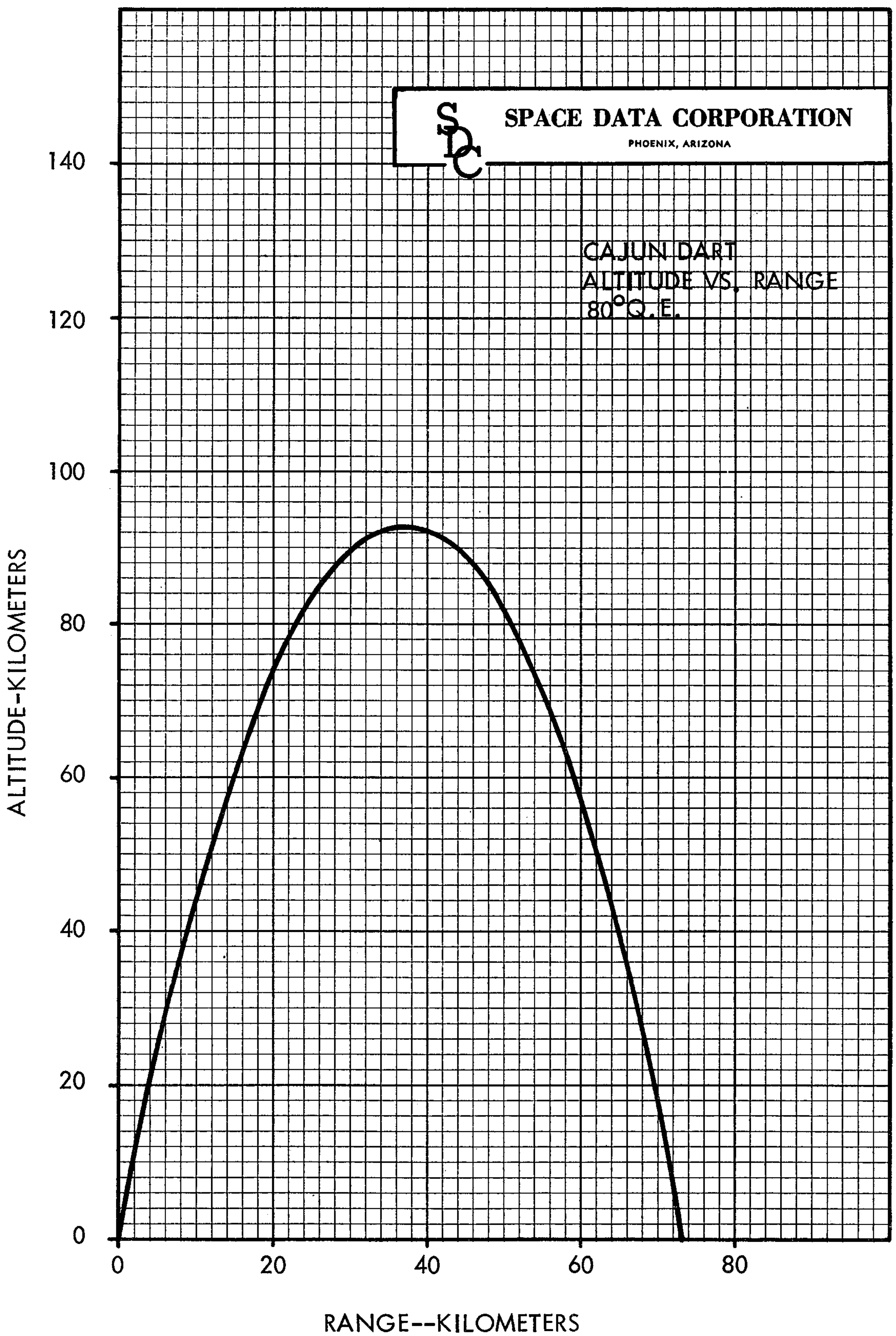

SPACE DATA CORPORATION
PHOENIX, ARIZONA
CAJUN DART
ALTITUDE VS. RANGE
80°Q.E.
ALTITUDE-KILOMETERS
140
120
100
80
60
40
20
0
0
20
40
60
80
RANGE--KILOMETERS

FIGURE 7

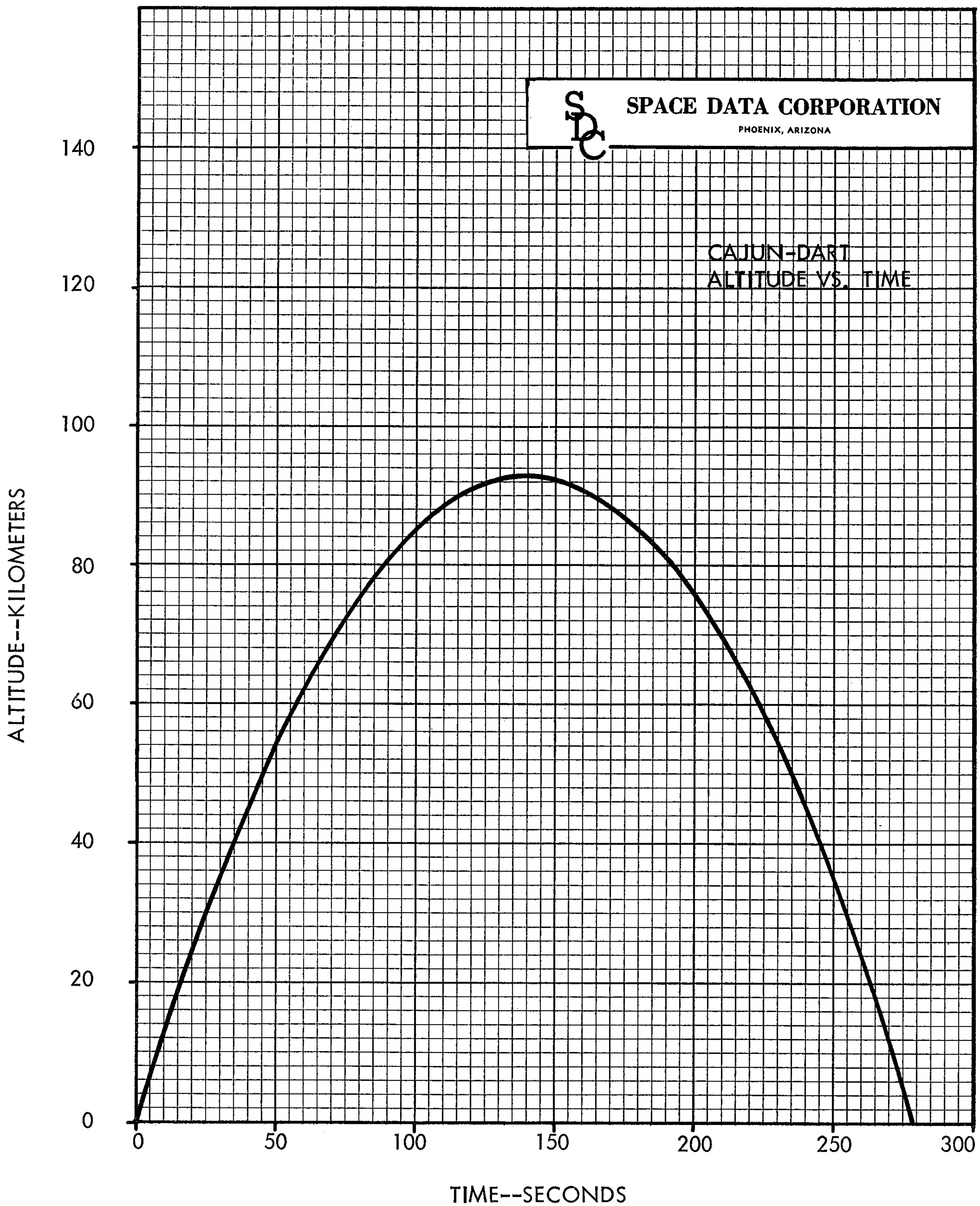

SPACE DATA CORPORATION
PHOENIX, ARIZONA
CAJUN-DART
ALTITUDE VS. TIME
ALTITUDE--KILOMETERS
TIME--SECONDS
0
20
40
60
80
100
120
140
0
50
100
150
200
250
300

FIGURE 8

PROGRAM DESCRIPTION

The Cajun Dart flight performance has been very satisfactory. The first flight was conducted by Space Data Corporation in May 1964, prior to awarding of any contract for the system. This first test was successful and the data obtained from it provided valuable background information for the production systems under the contract.

The first six flights of the NASA program were conducted as tests of the system at Eglin Air Force Base Florida, in order to provide actual flight data for the Air Force Eastern Test Range, Cape Kennedy.

Space Data Corporation has reduced the high level winds from the Eglin flights, and plots showing the wind speed and direction are included in Appendix C.

After the Eglin tests a Range Safety Report was prepared for AFETR containing both actual and theoretical performance data as well as certain design features of interest from a safety viewpoint. A copy of the report is in Appendix A.

In order to assist the range crews in the launching of the Cajun Dart a detailed assembly and checkout procedure, with pictures, was prepared and shipped with each unit sent to the range. This brochure is in Appendix B.

The program of Cajun Dart flights at AFETR was begun in February, 1965, on a scheduled one flight per week program. Twenty four vehicles had been launched through July 1965, from Cape Kennedy. (See Figures 9 and 10). A summary of the flights, and the ejection altitude, is shown in Table 1.

Cajun-Dart

SOUNDING VEHICLE

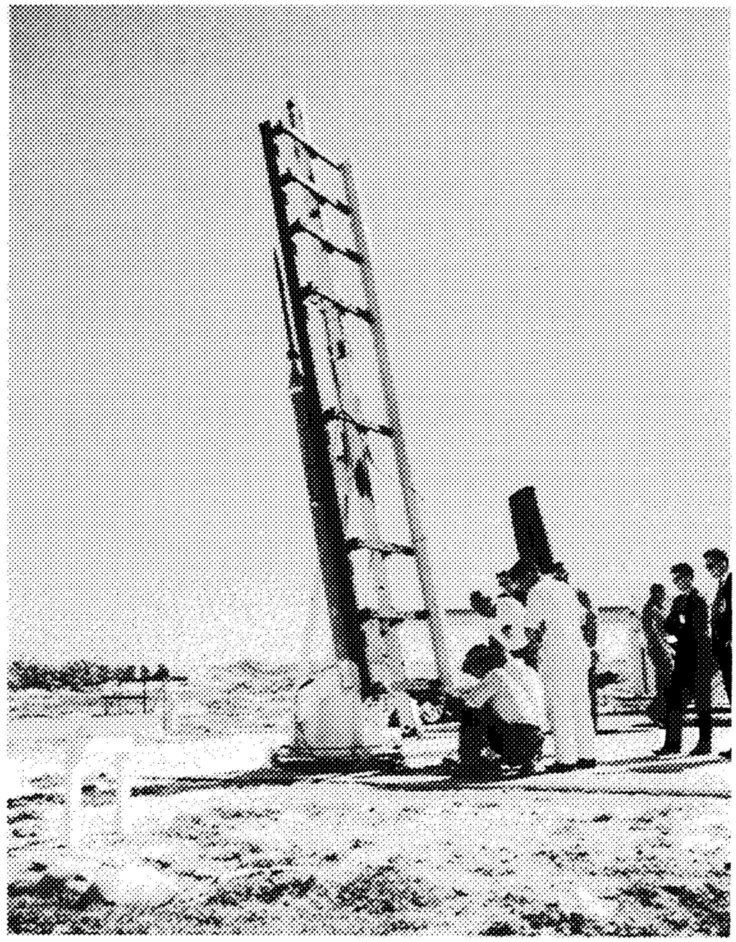


FIG. 9

ASSEMBLED VEHICLE READY FOR LAUNCHING AT CAPE KENNEDY.

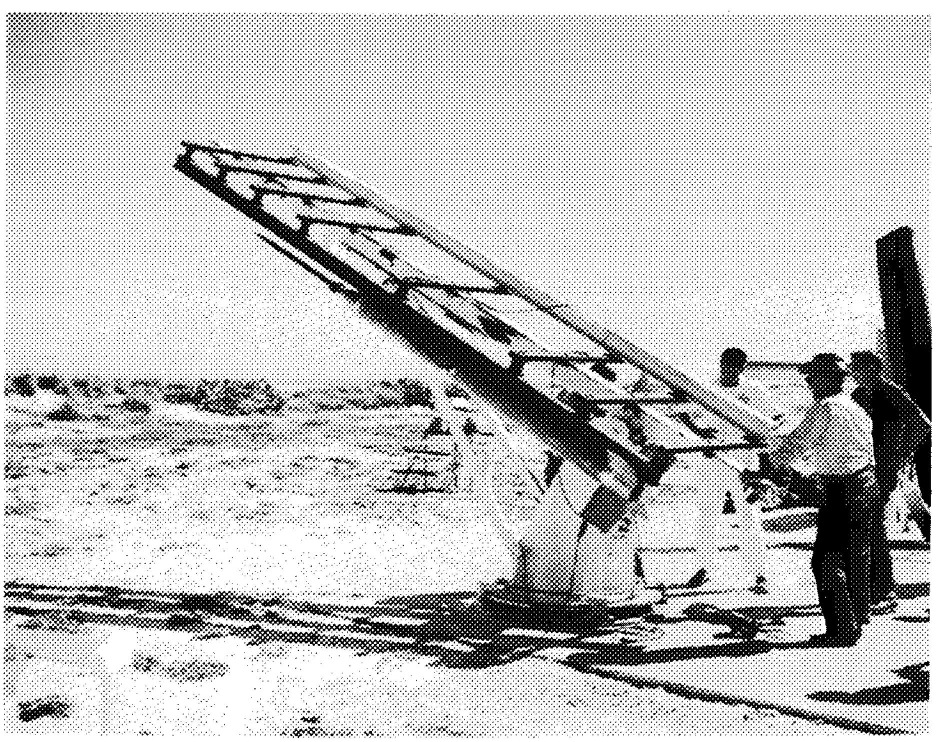


FIG. 10

ASSEMBLED VEHICLE ON LAUNCHER READY FOR ELEV-ATION TO LAUNCH POSITION.

TABLE 1

CAJUN-DART FLIGHT TEST RESULTS
CONTRACT NAS8-11624

FLIGHT NO.	DATE	LAUNCH SITE	TEST RESULTS (1)
1	19 Aug. 64	Eglin AFB	Successful
2	21 Aug. 64	Eglin AFB	Successful
3	24 Aug. 64	Eglin AFB	Successful
4	28 Aug. 64	Eglin AFB	Successful
5	16 Oct. 64	Eglin AFB	Unsuccessful
6	22 Oct. 64	Eglin AFB	Successful
7	17 Feb. 65	AFETR	Successful
8	24 Feb. 65	AFETR	Successful
9	26 Feb. 65	AFETR	Successful
10	5 Mar. 65	AFETR	No Acquisition (2)
11	10 Mar. 65	AFETR	Successful
12	17 Mar. 65	AFETR	Successful
13	24 Mar. 65	AFETR	Successful
14	31 Mar. 65	AFETR	Successful
15	7 Apr. 65	AFETR	Successful
16	14 Apr. 65	AFETR	Successful
17	21 Apr. 65	AFETR	Successful
18	28 Apr. 65	AFETR	No Acquisition
19	12 May 65	AFETR	Successful
20	26 May 65	AFETR	Successful
21	2 June 65	AFETR	Successful
22	11 June 65	AFETR	Successful
23	16 June 65	AFETR	Successful
24	23 June 65	AFETR	Successful
25	30 June 65	AFETR	Successful
26	7 July	AFETR	Successful
27	14 July 65	AFETR	Unsuccessful
28	21 July 65	AFETR	Successful
29	23 July 65	AFETR	Successful
30	28 July 65	AFETR	Successful

(1) "Successful" Available Information indicates wind data was obtained in the 90 to 70 km region.
"Unsuccessful" Data Available Indicates Chaff Ejection was low

(2) Failure to acquire chaff was attributed to wiring of firing circuit

APPENDIX A

CAJUN DART RANGE SAFETY INFORMATION

SDC TM-40

CAJUN DART

VEHICLE INFORMATION

SDC TM 40
REVISION B
13 SEPT 1965

CAJUN-DART VEHICLE

Introduction

This information is being furnished to obtain approval to launch 54 Cajun-Dart vehicles from AFMTC for Marshall Space Flight Center under contract number NAS8-11624. SPACE DATA CORPORATION is manufacturing this system and therefore is providing this documentation.

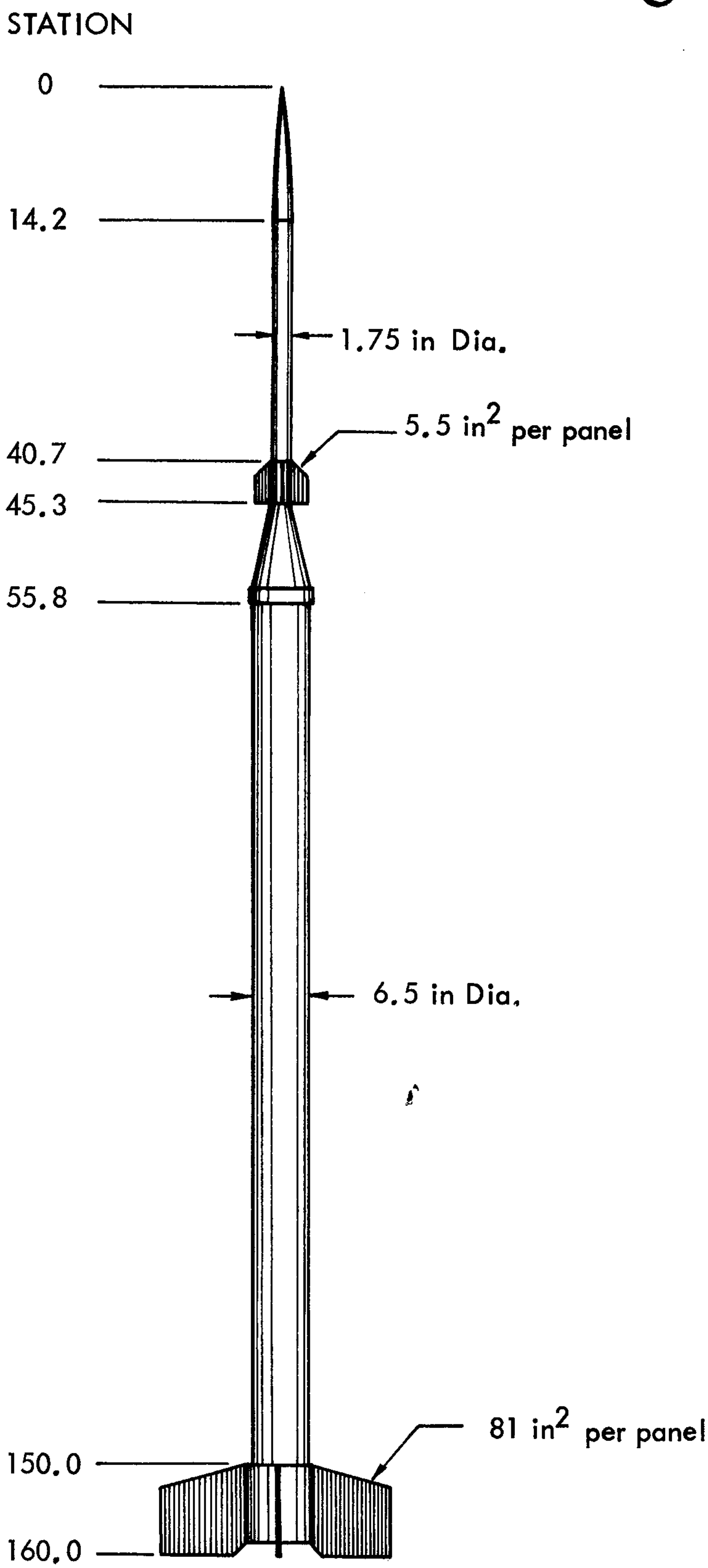
The Cajun-Dart vehicle is a two stage, boosted dart-type vehicle. The Cajun rocket motor boosts the inert dart through burning and then drag separates. The dart then coasts to an altitude of 90 to 95 kilometers, where the chaff payload is ejected.

The Cajun rocket motor is a solid propellant motor manufactured by Thiokol Chemical Corporation. It is 102 inches long, weighs 168 pounds at launch and produces approximately 25,250 pound-seconds of impulse. The rocket motor burns for 2.8 seconds and at burnout has imparted a velocity of 5000 feet per second to the dart. This rocket motor has been used for propulsion of a large number of vehicles and has proven to be very reliable.

The dart, or second stage, is 51.7 inches long and weighs 17 pounds. From its separation at 2.8 seconds and 7200 feet altitude, the dart coasts to an apogee of 90 to 95 kilometers at approximately 145 seconds. At apogee, the ejection device actuates and the payload of 30 cubic inches (approximately 1 pound) of metallized mylar chaff is ejected. This chaff dart is the only payload to be flown in this project.

The chaff is tracked by radar and wind information in the 87 to 60 kilometer altitude bans is obtained.

SPACE DATA CORPORATION
PHOENIX, ARIZONA



Weight Information

DART

Case	4.95
Ogive	7.00
Tail Ass'y	2.56
Chaff, Staves, etc.	2.77
Total	17.28 Lb.

CAJUN

Interstage	4.00
Fins	7.32
Motor Hardware	49.3
Total @ Burnout	76.90
Propellant	118.5 Lb.
Total Vehicle at Launch	196.40 Lb.

CAJUN-DART THRUST & PROPELLANT WEIGHT

Time	Thrust	Prop. Wt.
0.	2145	119
0.1	7150	116.77
0.4	7150	106.48
1.7	8275	58.37
2.2	8478	38.27
2.6	9194	21.31
2.8	9807	12.19
2.9	9194	7.63
3.	7662	3.59
3.1	0	1.75
3.5	0	0

CAJUN-DART DRAG COEFFICIENTS

Mach No.	Vehicle Thrusting Cd	Booster Coasting Cd
0.0	.664	.609
.25	.647	
.50	.635	.594
.75	.625	.653
1.0	.828	.846
1.25	.808	.746
1.50	.642	.657
1.75	.580	
2.00	.540	.553
2.50	.488	
3.00	.451	.449
3.5	.423	
4.0	.398	.380
10.0	.398	.341

Ref Area: 0.2485 FT^2

DART COASTING

Mach	Cd
0.0	.700
2.6	.700
2.8	.560
3.0	.465
3.3	.360
3.5	.305
3.7	.263
4.0	.210
4.3	.175
4.6	.152
5.0	.132
5.2	.130
10.0	.130

Ref Area: 0.0167 FT^2

These drag coefficients were obtained by calculating theoretical values and then adjusting to match predicted trajectories with actual flights.

TWO DEGREE OF FREEDOM - POINT MASS PROGRAM

CC-18 CAJUN CHAFF DART

+10 PERCENT DRAG
29 JUNE 1964 17 LB DART

DELT	AREA	THETA	AMN	TALC	TIM	YSTOP
0.1	0.2485	80.0	196.40	1.00	1.0	140000.0

FN	ADN	AGN	VTN	YN	RN	TTEST
2145.0	0.	31.685	0.	0.	0.	1000.0

WGT	WPN	WK
77.400	119.000	1.0000

LINE 1
COLUMN 1 TIME(SEC)

LINE 2
COLUMN 1 TOTAL VELOCITY(FPS)
2 ALTITUDE(FT)
3 FLIGHT PATH ANGLE(DEG)
4 MACH NUMBER(DIMENSIONLESS)
5 DRAG(LB)

LINE 3
COLUMN 1 TOTAL ACCELERATION(FPS2)
2 ACCELERATION-DRAG(FPS2)
3 ACCELERATION-THRUST(FPS2)
4 RANGE(FT)
5 DYNAMIC PRESSURE

LINE 4
COLUMN 1 THRUST(LB)
2 MASS(LBS)
3 DRAG COEFFICIENT(DIMENSIONLESS)
4 HORIZONTAL VELOCITY(FPS)
5 VERTICAL VELOCITY(FPS)

0.				
0.	0.	80.0	0.	0.
319.7	0.	351.4	0.	0.
2145.0	196.400	0.664	0.	0.
1.00				
1221.7	556.9	78.8	1.1	355.9
1424.6	70.0	1526.2	109.4	1745.8
7669.2	161.675	0.820	237.1	1198.5
2.00				
2865.4	2523.7	78.6	2.6	1083.9
1874.9	277.4	2183.8	503.5	9060.6
8396.8	123.710	0.481	565.8	2809.0
3.00				
5117.0	6373.3	78.5	4.7	2544.5
2026.1	986.2	3043.8	1283.5	25727.1

```
   7662.0       80.990      0.398     1019.0      5014.6

   3.20
  5061.0       7378.2      78.5        4.7       2413.4
 -1015.3        983.8       0.      1486.4      24402.0
     0.        78.712      0.398    1009.1       4959.4

NOW IN COAST STAGE

      AREA        AMO        TTEST
    0.01837   17.00000      1000.0
NUMS
 0

   4.00
  4942.2      11297.8      78.4        4.6         57.2
  -139.7        108.2       0.      2286.2      20587.4
     0.        17.000      0.151     990.4       4841.9

   5.00
  4812.3      16074.0      78.4        4.6         47.2
  -120.8         89.3       0.      3266.7      16733.9
     0.        17.000      0.154     970.6       4713.4

   6.00
  4699.6      20730.3      78.3        4.6         39.0
  -105.2         73.8       0.      4229.1      13656.2
     0.        17.000      0.155     954.1       4601.7

   7.00
  4601.1      25282.1      78.2        4.5         32.1
   -92.2         60.8       0.      5176.5      11178.3
     0.        17.000      0.156     940.4       4503.9

   8.00
  4514.5      29742.1      78.1        4.5         26.4
   -81.3         49.9       0.      6111.4       9166.4
     0.        17.000      0.157     929.1       4417.9

   9.00
  4437.9      34121.1      78.0        4.5         21.6
   -72.2         40.8       0.      7036.0       7521.0
     0.        17.000      0.156     919.8       4341.5

  10.00
  4369.6      38427.9      77.9        4.5         17.6
   -64.7         33.4       0.      7952.2       6047.7
     0.        17.000      0.159     912.1       4273.3

  11.00
  4308.0      42669.9      77.9        4.4         14.4
   -58.6         27.3       0.      8861.3       4798.0
     0.        17.000      0.164     905.7       4211.7

  12.00
  4251.9      46853.1      77.8        4.4         11.8
   -53.7         22.4       0.      9764.7       3825.9
     0.        17.000      0.168     900.5       4155.5

  13.00
  4200.4      50982.3      77.7        4.3          9.7
   -49.6         18.3       0.     10663.3       3064.4
     0.        17.000      0.172     896.2       4103.6

  14.00
  4152.4      55061.6      77.6        4.3          8.0
```

-46.4	15.1	0.	11558.0	2464.1
0.	17.000	0.176	892.6	4055.4
15.00				
4107.4	59094.0	77.5	4.2	6.6
-43.8	12.6	0.	12449.4	1988.3
0.	17.000	0.182	889.6	4009.9
16.00				
4064.7	63082.1	77.4	4.2	5.5
-41.7	10.5	0.	13338.1	1609.3
0.	17.000	0.187	887.1	3966.7
17.00				
4023.9	67028.0	77.3	4.2	4.6
-39.9	8.7	0.	14224.5	1304.2
0.	17.000	0.192	885.0	3925.4
18.00				
3984.8	70933.4	77.2	4.1	3.8
-38.4	7.2	0.	15109.0	1056.5
0.	17.000	0.197	883.3	3885.7
19.00				
3947.1	74799.8	77.1	4.1	3.2
-37.1	6.0	0.	15991.8	858.8
0.	17.000	0.201	881.8	3847.3
20.00				
3910.4	78628.4	77.0	4.0	2.6
-36.1	5.0	0.	16873.3	700.5
0.	17.000	0.206	880.6	3810.0
21.00				
3874.8	82420.1	76.9	4.0	2.2
-35.3	4.2	0.	17753.7	573.1
0.	17.000	0.210	879.5	3773.6
22.00				
3839.8	86175.9	76.8	3.9	1.9
-34.7	3.6	0.	18633.1	470.2
0.	17.000	0.222	878.6	3737.9
23.00				
3805.4	89896.1	76.7	3.9	1.7
-34.2	3.1	0.	19511.7	386.9
0.	17.000	0.233	877.8	3702.7
24.00				
3771.4	93581.4	76.5	3.8	1.4
-33.7	2.7	0.	20389.6	319.2
0.	17.000	0.244	877.2	3668.0
25.00				
3737.9	97232.2	76.4	3.7	1.2
-33.3	2.3	0.	21266.8	264.0
0.	17.000	0.255	876.6	3633.6
26.00				
3704.7	100848.9	76.3	3.7	1.1
-33.0	2.0	0.	22143.4	219.0
0.	17.000	0.266	876.0	3599.7
27.00				
3671.9	104431.6	76.2	3.6	0.9
-32.7	1.8	0.	23019.6	182.0

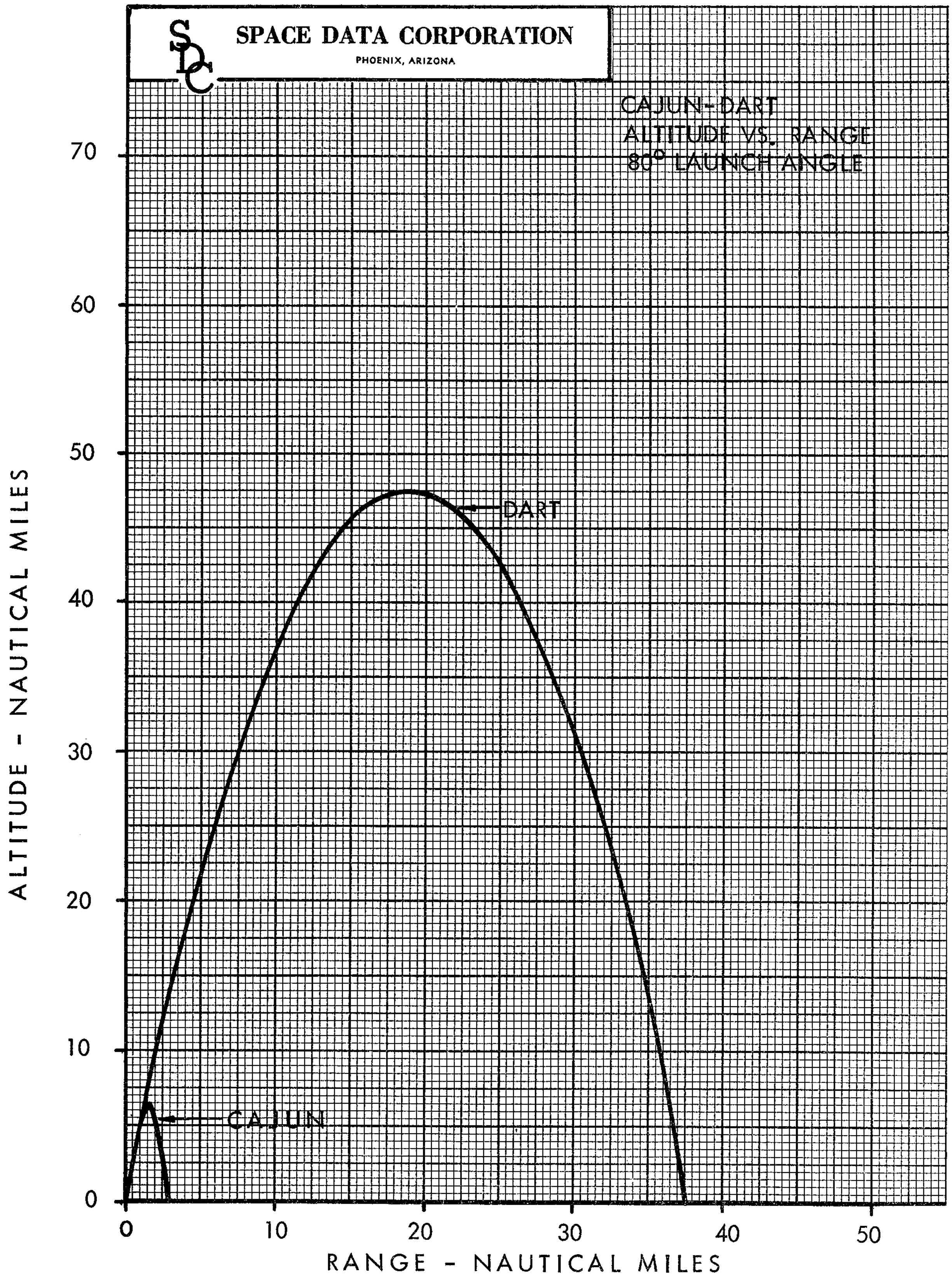
0.	17.000	0.278	875.6	3566.0
28.00				
3639.3	107980.9	76.1	3.6	0.8
-32.4	1.5	0.	23895.4	150.9
0.	17.000	0.290	875.2	3532.5
29.00				
3607.0	111496.8	76.0	3.5	0.7
-32.2	1.3	0.	24770.8	125.2
0.	17.000	0.302	874.8	3499.3
30.00				
3574.9	114979.6	75.8	3.5	0.6
-32.0	1.1	0.	25645.8	104.3
0.	17.000	0.316	874.5	3466.3
31.00				
3543.0	118429.4	75.7	3.4	0.5
-31.8	1.0	0.	26520.6	87.1
0.	17.000	0.331	874.3	3433.4
32.00				
3511.3	121846.5	75.6	3.4	0.5
-31.7	0.9	0.	27395.1	73.1
0.	17.000	0.345	874.0	3400.7
33.00				
3479.6	125230.9	75.4	3.3	0.4
-31.5	0.8	0.	28269.4	61.5
0.	17.000	0.359	873.8	3368.1
34.00				
3448.2	128582.8	75.3	3.3	0.4
-31.4	0.7	0.	29143.6	51.9
0.	17.000	0.375	873.6	3335.7
35.00				
3416.8	131902.3	75.2	3.2	0.3
-31.3	0.6	0.	30017.5	44.0
0.	17.000	0.392	873.5	3303.3
36.00				
3385.5	135189.4	75.0	3.2	0.3
-31.2	0.5	0.	30891.3	37.3
0.	17.000	0.409	873.3	3271.0
37.00				
3354.4	138444.2	74.9	3.1	0.2
-31.1	0.5	0.	31764.9	31.8
0.	17.000	0.425	873.2	3238.7
38.00				
3323.3	141666.9	74.8	3.1	0.2
-31.0	0.4	0.	32638.4	27.2
0.	17.000	0.441	873.1	3206.6

QC	P	A	E
0.16558E-01	0.24054E 05	0.10622E 08	0.99887E 00

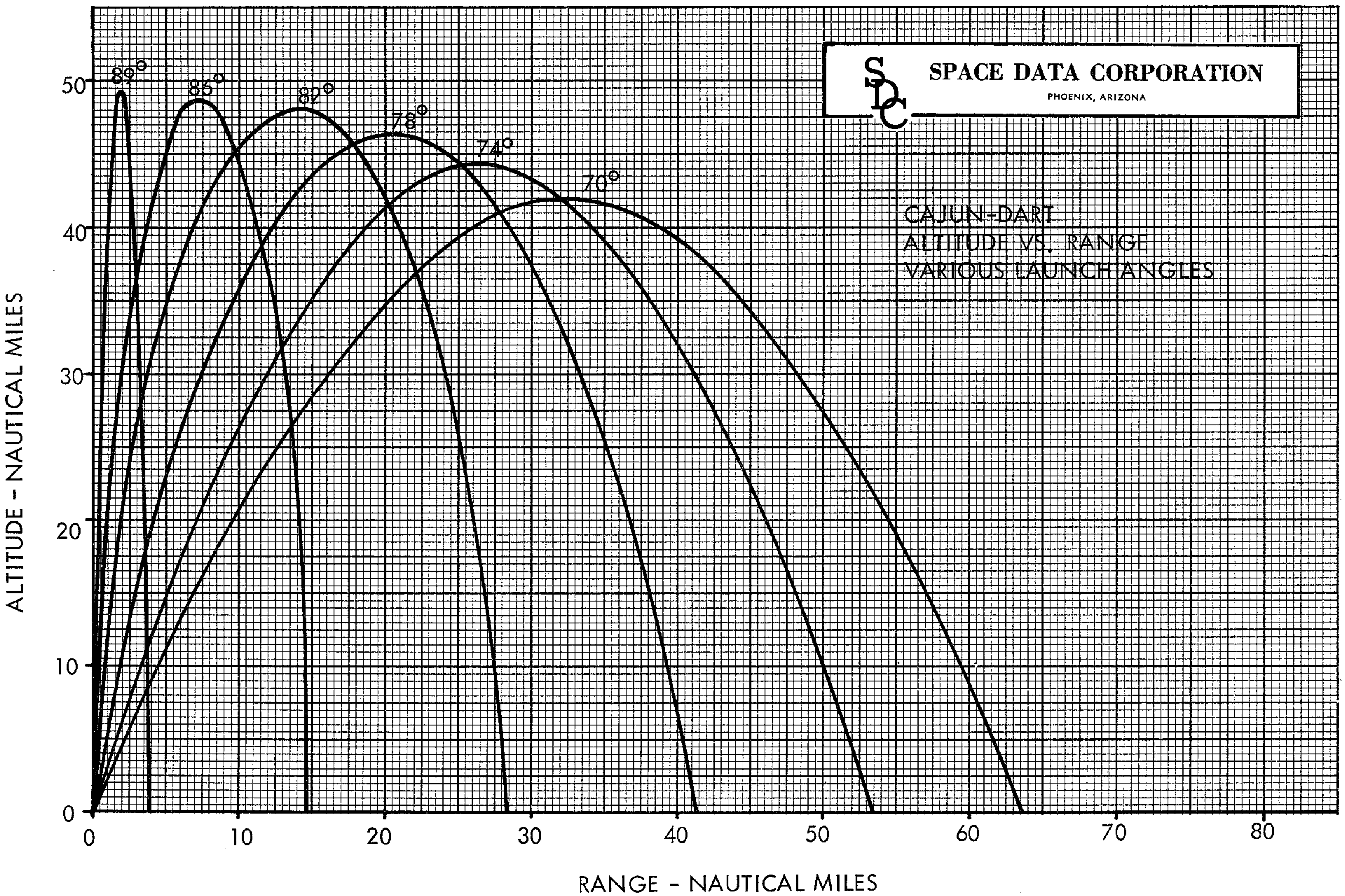
HA	XA	TA	XI	TI
0.30519E 06	0.12044E 06	0.14036E 03	0.24080E 06	0.27991E 03

H	X	T
0.14635E 06	0.33912E 05	0.39570E 02
0.15135E 06	0.35295E 05	0.41165E 02

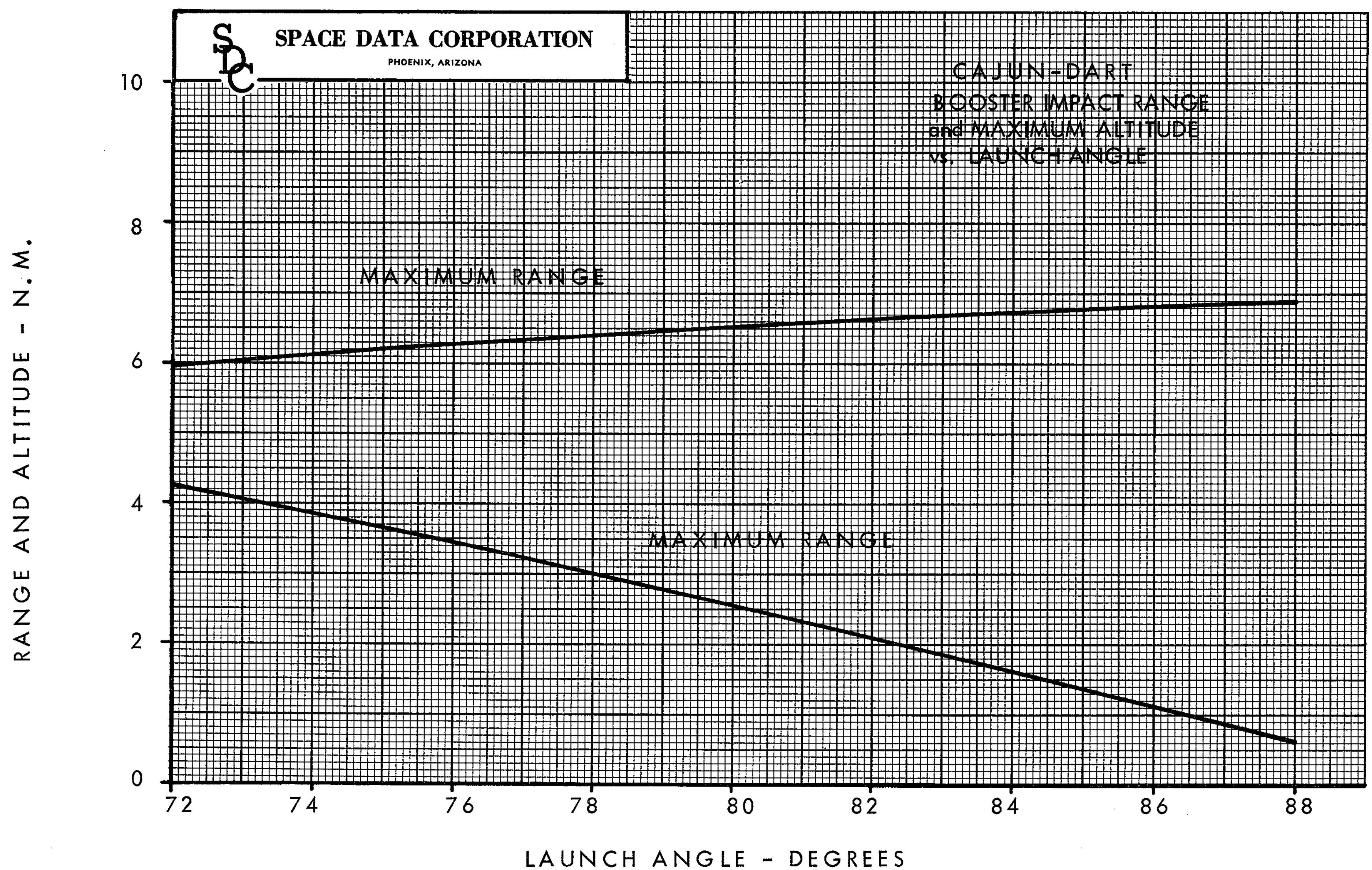
0,15635E 06	0,36705E 05	0,42786E 02
0,16135E 06	0,38130E 05	0,44435E 02
0,16635E 06	0,39579E 05	0,46114E 02
0,17135E 06	0,41066E 05	0,47823E 02
0,17635E 06	0,42570E 05	0,49564E 02
0,18135E 06	0,44104E 05	0,51339E 02
0,18635E 06	0,45670E 05	0,53152E 02
0,19135E 06	0,47269E 05	0,55002E 02
0,19635E 06	0,48898E 05	0,56895E 02
0,20135E 06	0,50576E 05	0,58831E 02
0,20635E 06	0,52284E 05	0,60815E 02
0,21135E 06	0,54036E 05	0,62850E 02
0,21635E 06	0,55842E 05	0,64940E 02
0,22135E 06	0,57693E 05	0,67090E 02
0,22635E 06	0,59600E 05	0,69305E 02
0,23135E 06	0,61569E 05	0,71592E 02
0,23635E 06	0,63600E 05	0,73959E 02
0,24135E 06	0,65713E 05	0,76413E 02
0,24635E 06	0,67910E 05	0,78965E 02
0,25135E 06	0,70196E 05	0,81629E 02
0,25635E 06	0,72591E 05	0,84420E 02
0,26135E 06	0,75112E 05	0,87358E 02
0,26635E 06	0,77782E 05	0,90470E 02
0,27135E 06	0,80620E 05	0,93789E 02
0,27635E 06	0,83699E 05	0,97365E 02
0,28135E 06	0,87037E 05	0,10127E 03
0,28635E 06	0,90747E 05	0,10560E 03
0,29135E 06	0,95008E 05	0,11057E 03
0,29635E 06	0,10013E 06	0,11655E 03
0,30135E 06	0,10705E 06	0,12466E 03
0,30135E 06	0,13384E 06	0,15606E 03

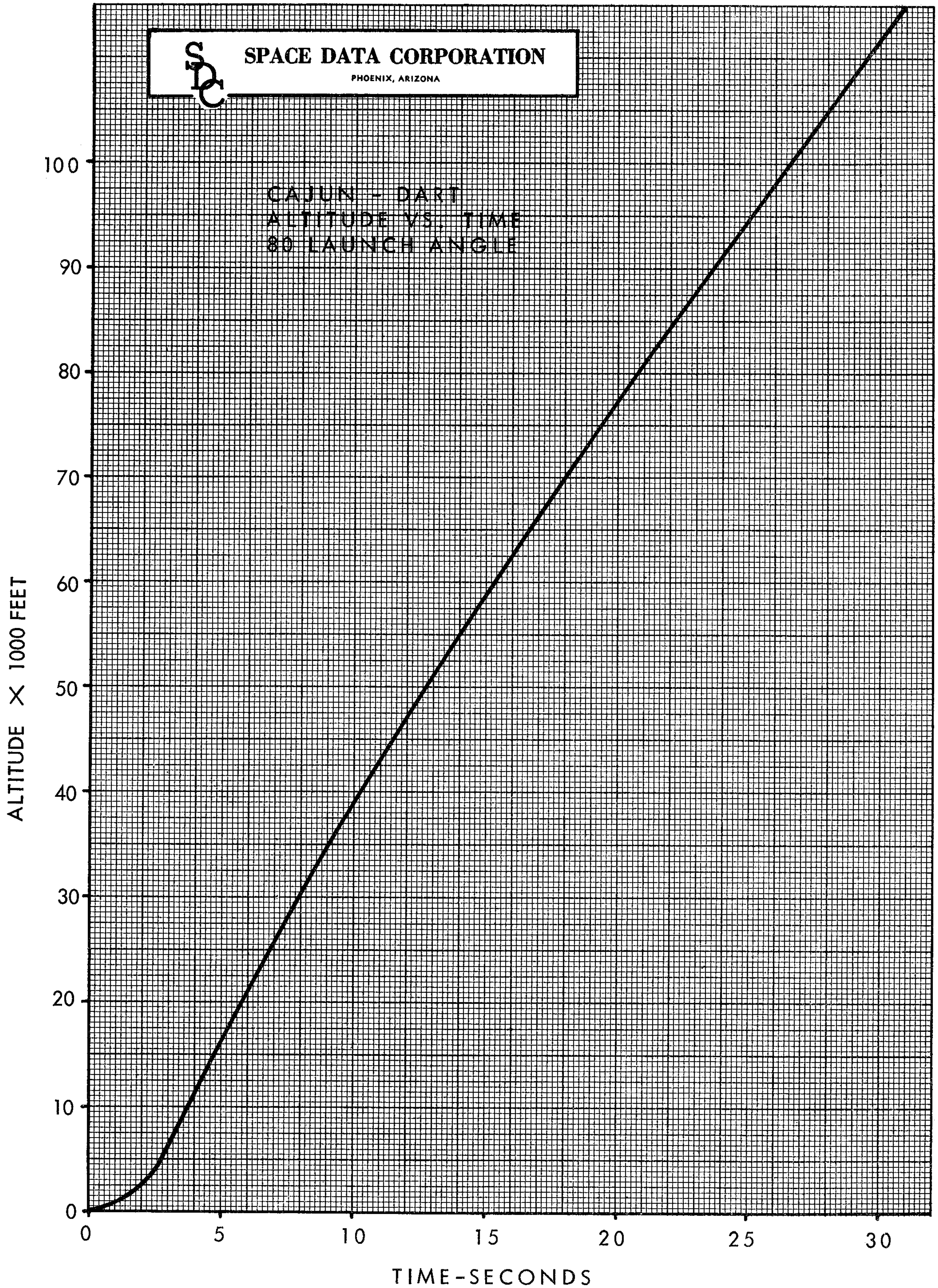


SPACE DATA CORPORATION
PHOENIX, ARIZONA
CAJUN-DART
ALTITUDE VS. RANGE
80° LAUNCH ANGLE
DART
CAJUN
ALTITUDE - NAUTICAL MILES
RANGE - NAUTICAL MILES
0
10
20
30
40
50
60
70

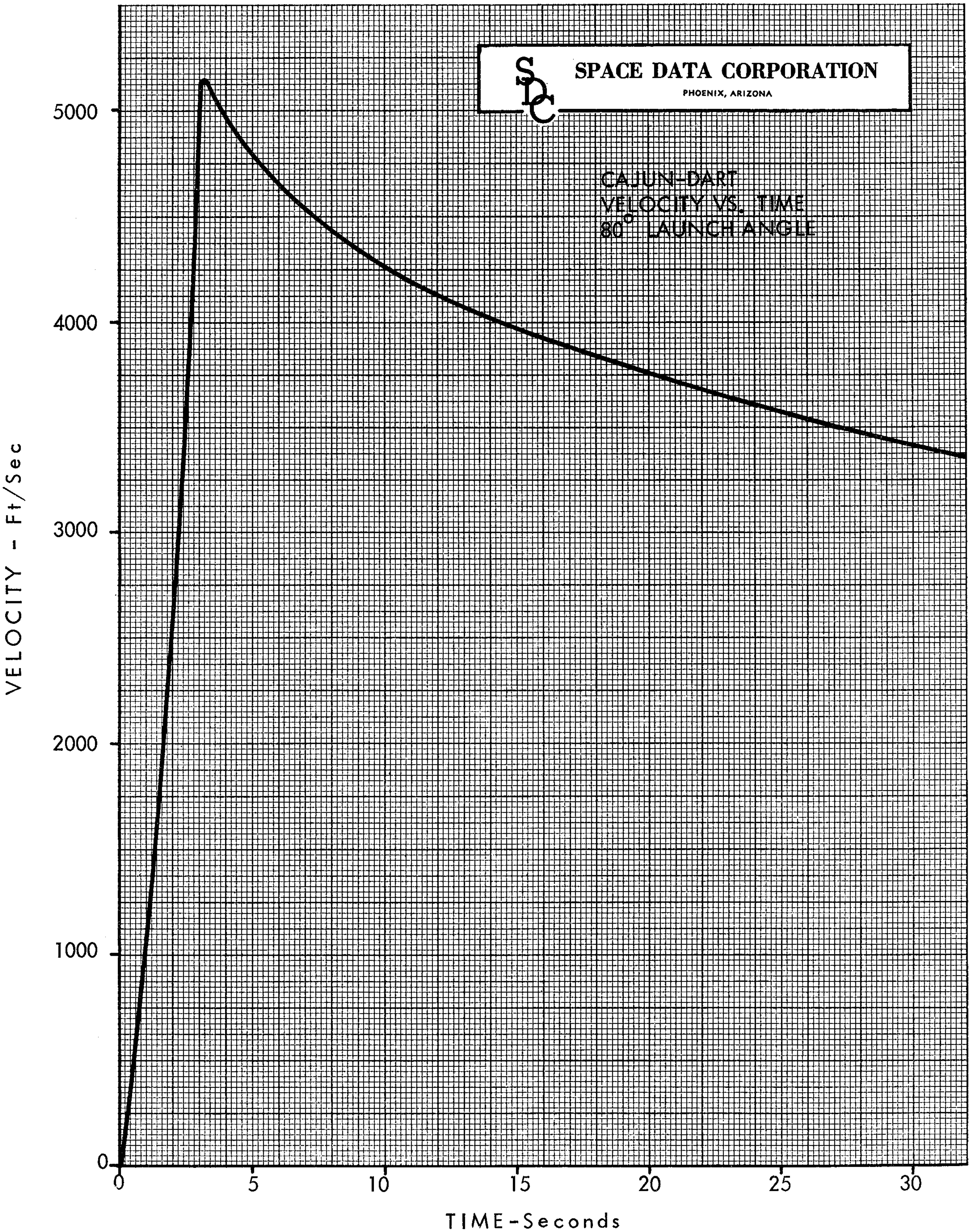


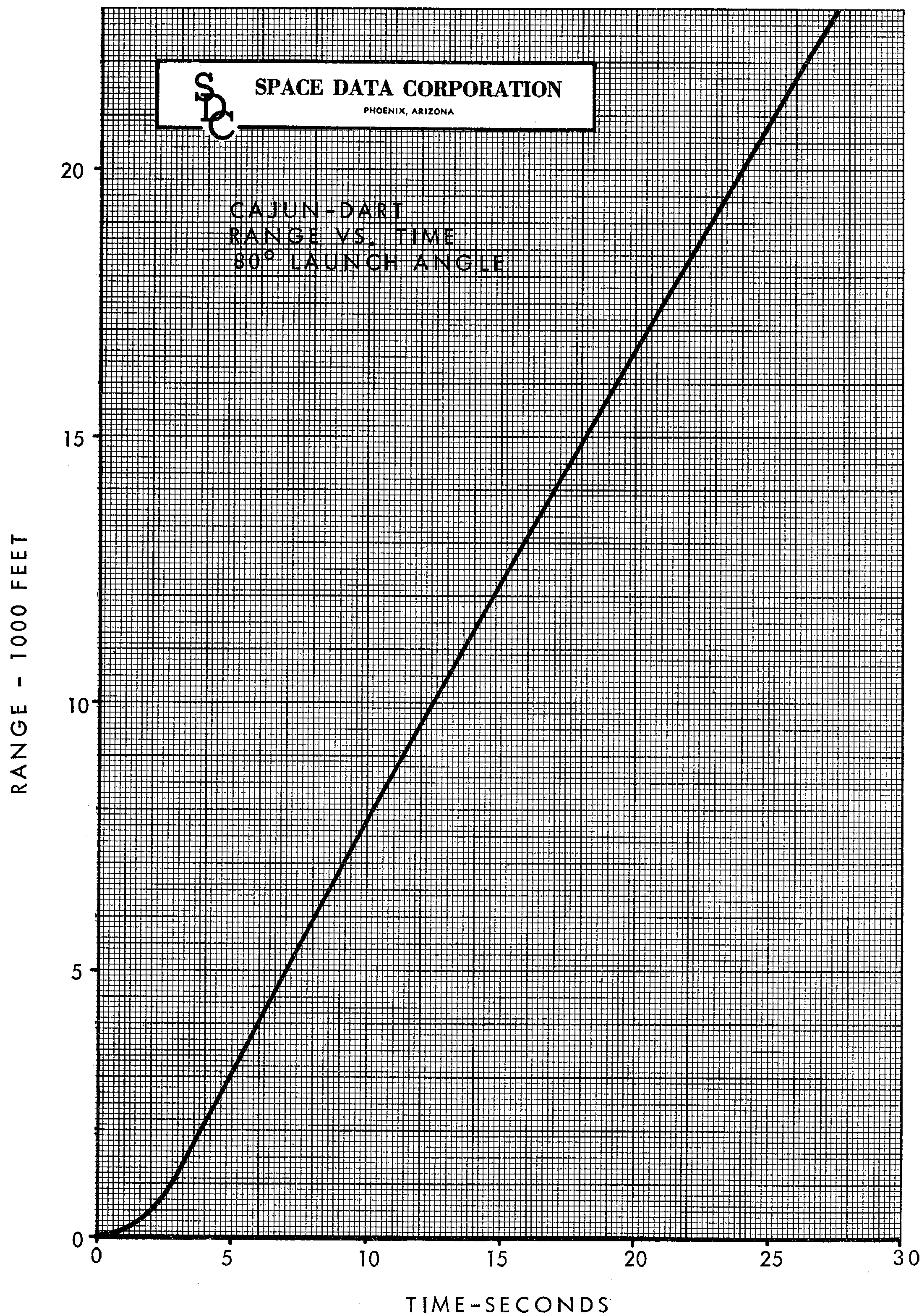
SPACE DATA CORPORATION
PHOENIX, ARIZONA
SDC
CAJUN-DART
ALTITUDE VS. RANGE
VARIOUS LAUNCH ANGLES
89°
86°
82°
78°
74°
70°
ALTITUDE - NAUTICAL MILES
RANGE - NAUTICAL MILES
0
10
20
30
40
50
60
70
80


SPACE DATA CORPORATION
PHOENIX, ARIZONA
CAJUN-DART
BOOSTER IMPACT RANGE
and MAXIMUM ALTITUDE
vs. LAUNCH ANGLE
MAXIMUM RANGE
MAXIMUM RANGE
RANGE AND ALTITUDE - N.M.
0
2
4
6
8
10
72
74
76
78
80
82
84
86
88
LAUNCH ANGLE - DEGREES

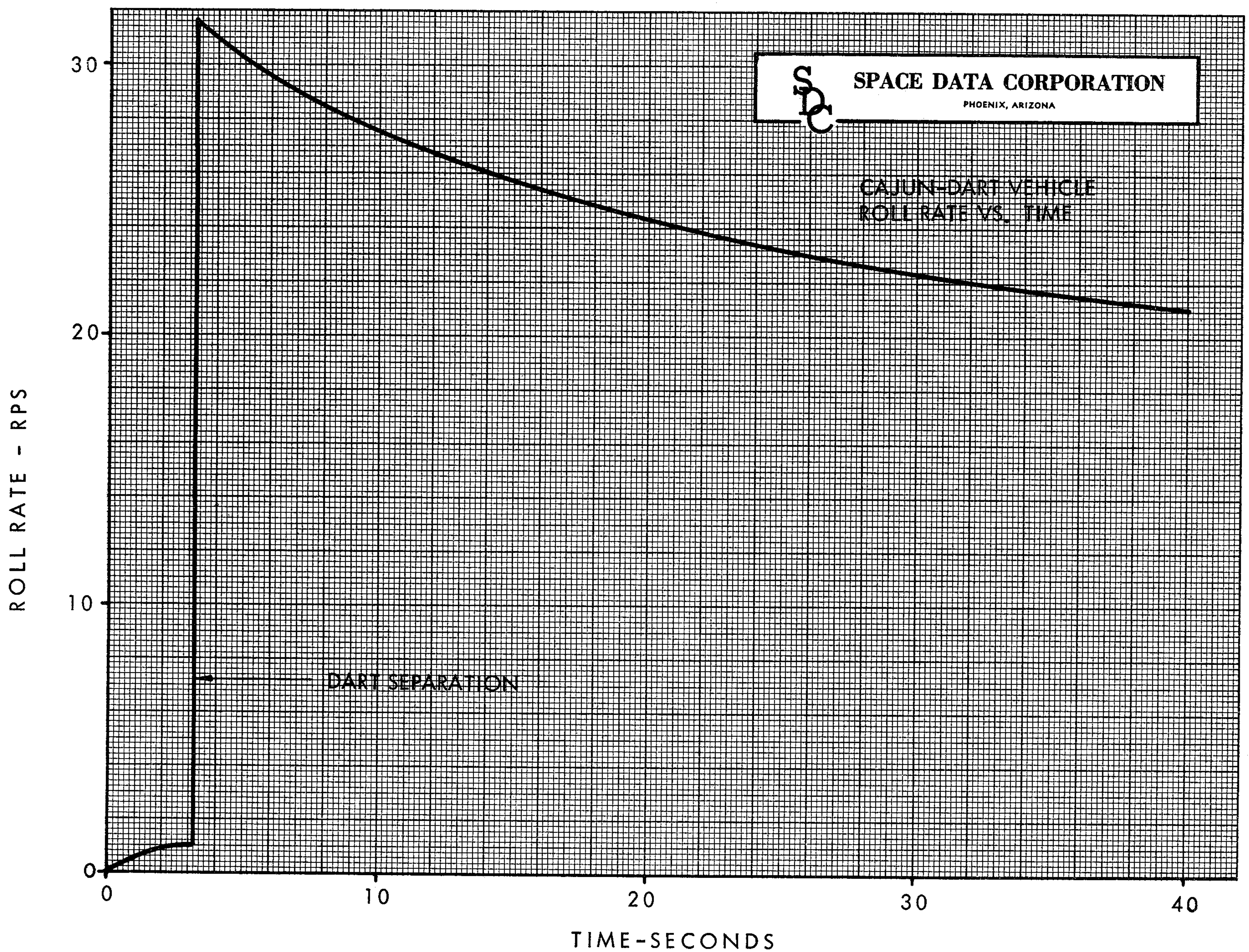


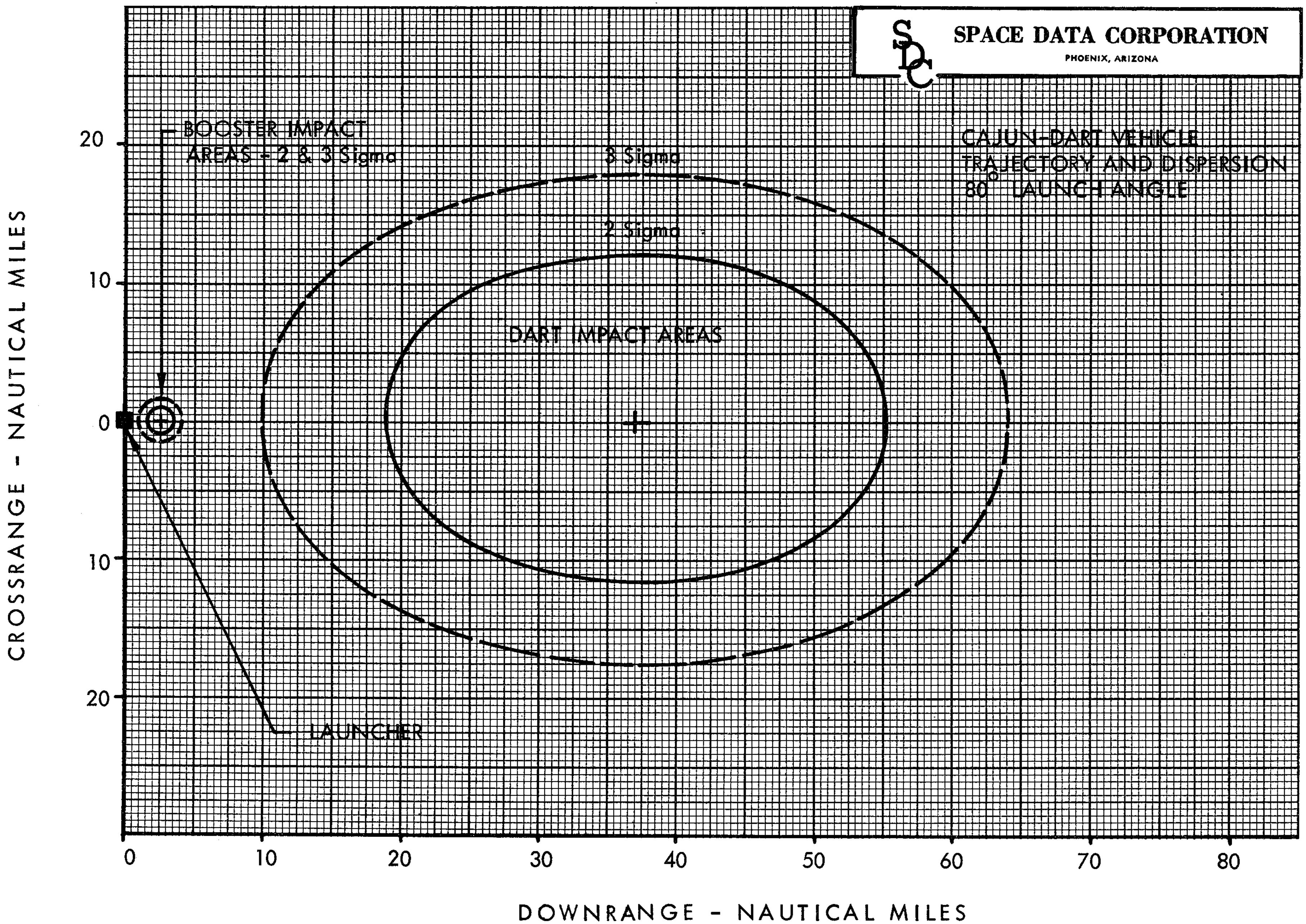
SPACE DATA CORPORATION
PHOENIX, ARIZONA
CAJUN - DART
ALTITUDE VS. TIME
80 LAUNCH ANGLE
ALTITUDE X 1000 FEET
0
10
20
30
40
50
60
70
80
90
100
0
5
10
15
20
25
30
TIME-SECONDS


SPACE DATA CORPORATION
PHOENIX, ARIZONA
CAJUN-DART
VELOCITY VS. TIME
80° LAUNCH ANGLE
VELOCITY - Ft/Sec
0
1000
2000
3000
4000
5000
0
5
10
15
20
25
30
TIME-Seconds



SPACE DATA CORPORATION
PHOENIX, ARIZONA
CAJUN-DART
RANGE VS. TIME
80° LAUNCH ANGLE
RANGE - 1000 FEET
TIME-SECONDS
0
5
10
15
20
25
30


SPACE DATA CORPORATION
PHOENIX, ARIZONA
CAJUN-DART VEHICLE
ROLL RATE VS. TIME
DART SEPARATION
ROLL RATE - RPS
TIME-SECONDS
0
10
20
30
40



SPACE DATA CORPORATION
PHOENIX, ARIZONA
CAJUN-DART VEHICLE
TRAJECTORY AND DISPERSION
80° LAUNCH ANGLE
BOOSTER IMPACT
AREAS - 2 & 3 Sigma
3 Sigma
2 Sigma
DART IMPACT AREAS
LAUNCHER
CROSSRANGE - NAUTICAL MILES
DOWNRANGE - NAUTICAL MILES
20
10
0
10
20
0
10
20
30
40
50
60
70
80

CAJUN DART

WIND WEIGHTING INFORMATION

WIND WEIGHTING FACTORS

Altitude Increment	Dart Vehicle	Booster
0-100	.42	.43
100-200	.16	.17
200-300	.08	.08
300-400	.06	.05
400-500	.03	.03
500-1000	.09	.10
1000-7500	.16	.14

Unit Wind Effect

Dart Vehicle - .270 degrees elevation/knot of wind

Booster - 370 ft./knot of wind

This information taken from "Dispersion Study for the Cajun-Dart" which was prepared by APGC, Eglin AFB, Florida

WIND WEIGHTING SAMPLE

Altitude Increment	Wind Factor	Measured Velocity	Wind Azimuth	Ballistic Wind	N-S Component	E-W Component
1-100	.42	11.0	110°	4.620	-1.580	4.341
100-200	.16	11.5	106°	1.840	-0.507	1.769
200-300	.08	12.3	104°	.984	-0.238	0.955
300-400	.06	13.4	109°	..804	-0.262	0.760
400-500	.03	12.4	106°	.372	-0.103	0.358
500-1000	.09	11.7	103°	1.053	-0.237	1.026
1000-7500	.16	10.4	99°	1.664	-0.260	1.644
			Total Components		-3.187	10.853

$$\text{Total Ballistic Wind} = -3.187^2 + 10.853^2 = 11.311 \text{ knots}$$

$$\text{Direction} = \text{Arc Tan } \frac{-3.187}{10.853} = 106.4^\circ$$

Assume nominal no-wind launcher setting to be 80° QE and 90° AZ.

We have a headwind of 10.853 knots and a side wind from the right of 3.187 knots.

$$\text{New QE} = 80 + .270\,(10.853) = 82.9^\circ$$

$$\text{New AZ} = 90 + \frac{.270\,(-3.187)}{\text{Cos } 80^\circ} = 85.0^\circ$$

Notes:

1. Measured winds were assumed for example. These would normally be supplied by range meteorological network.
2. The components of ballistic wind obtained by resolving the measured wind times the weighting factor into components parallel with and perpendicular to the nominal flight azimuth.
3. North to South winds are positive (+)
   South to North winds are negative (-)
4. East to West Winds are positive (+)
   West to East winds are negative (-)

Malfunctions that could occur with the Cajun-Dart vehicle are:

1. Fin or fin assembly loss: Probability less than 2%

2. Motor burn through or nozzle loss: Probability of occurrence is less than .1%

3. Fin and nozzle misalignment: Probability is less than 1%

4. Misaligned thrust vector: Probability of occurrence to a serious extent is less than 1%

5. Other effects noted in dispersion analysis: Probability of occurrence in magnitude greater than that included in the dispersion analysis is less than 1%

None of these have occurred during seven flight tests to date. In addition, the excellent record of the Cajun rocket motor indicates an extremely low probability of a rocket motor malfunction.

Calculation of statistical probabilities has not been made. In place of these calculations, the following discussion of the above probabilities is presented.

1. Loss of a fin or fin assembly would in all probability occur late during the boost phase when dynamic pressure and fin temperature are near their maximum. At this time the vehicle has a high velocity along the flight trajectory and the rocket has very little energy remaining. Under these conditions it is very unlikely that the trajectory will be affected to an extent great enough to result in land impact. In addition, should the booster become unstable after separation, impact will occur very near to that expected for a normal flight, since the times of flight are essentially the same.

2. Motor burn through would also occur late in the flight and with the same results as noted in Item 1. However, both motor burn through and loss of the nozzle are considered to be extremely unlikely, based on the excellent history of Cajun flights without failures.

3. Fin and nozzle misalignment of a magnitude great enough to result in land impact would be the result of obvious damage to the vehicle before launch. Normal misalignment is included in the dispersion analysis and it is not expected that greater misalignments will occur.

4. The maximum thrust misalignment that could be normally expected (manufacturing tolerances, etc.) has been included in the dispersion analysis. In the unlikely event of a severe misalignment the flight would be unpredictable.

5. As noted, the other minor effects encountered during a rocket flight are not expected to cause errors in excess of those predicted in the dispersion analysis.

In conclusion, it is considered that the known reliability of the Cajun rocket motor plus the demonstrated flight worthiness of the vehicle system will assure the total probability of a successful flight is greater than 99%.

DESCRIPTION OF CAJUN IGNITER

This igniter is manufactured by Space Data Corporation. The igniter consists of a tube containing two Flare Northern 209 squibs, 7.5 grams of ignition powder and 90 grams of USF 2A granules. The two squibs are wired in parallel and are 1 amp, 1 watt type. (See AFMTC Form 87). The leads into the igniter are a twisted pair which are shielded and terminate in a self-shorting connector.

See enclosed Drawing SDC 215--49 for schematic.

For information, the following pertinent data on the 209 squib is listed:

Resistance (1 squib) - .95 - 1.25 ohms

Max. No Fire -1.8 amps

Min. All Fire - 2.4 Amps

Rec. Firing Current - 4.5 Amps

Igniter Resistance - .45 to 1.00 Ohms

Description of Payload Gas Ejection Device

The gas ejection device used to eject the payload is a small propellant charge initiated by a pyrotechnic time delay.

The pyrotechnic time delay is initiated at launch. It is connected in parallel with the rocket motor igniter and is initiated simultaneously. The delay column burns slowly for 145 seconds, then ignites a small flash charge which ignites the propellant, 6-1/2 grams of USF-2C granules.

When the propellant is ignited, the gases generated drive a piston which forces the dart ogive and a set of staves containing the chaff from the tube.

The ogive is restrained by three shear screws which release at a relatively low pressure, thereby assuring that there would be no shrapnel in case of accidental initiation.

The characteristics of the squib in the Unidynamics S-167-145 delay initiator are as follows:

Resistance - 1.0 ± 0.3 ohms

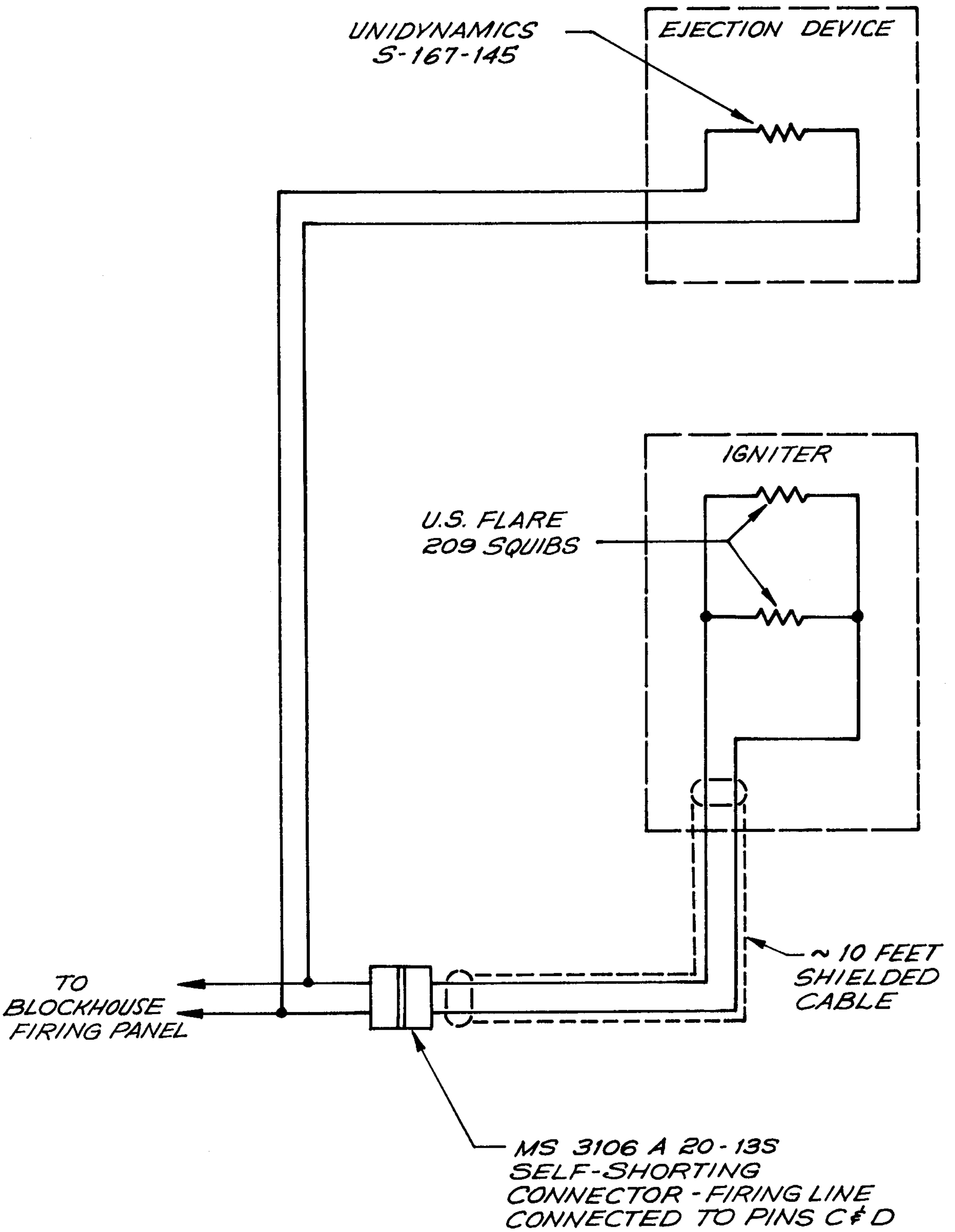
Max. No Fire - 0.5 Amps

Min. All Fire - 1.0 Amps

Rec. Firing Current - 2.0 Amps

Delay-bridgewire initiation to flash - 145 ± 15 seconds

SPACE DATA CORPORATION PHOENIX, ARIZONA	PREPARED BY R.O.H. DATE 11/18/64 CHECKED BY ______ DATE ______	PAGE 1 JOB 209
	SUBJECT CAJUN-DART SCHEMATIC	



APPENDIX B

CAJUN DART ASSEMBLY AND CHECKOUT PROCEDURE

SPACE DATA CORPORATION
PHOENIX, ARIZONA

ASSEMBLY AND CHECKOUT PROCEDURES FOR THE CAJUN DART ROCKET SYSTEM

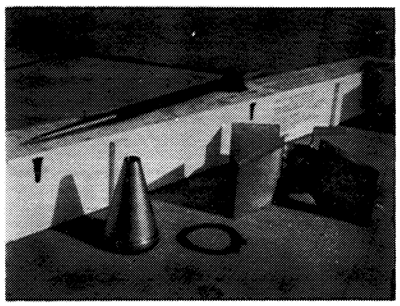
Prepared for
MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
(Contract NAS8-11624)
by
SPACE DATA CORPORATION
2875 Sky Harbor Blvd.
Phoenix, Arizona 85034

CAJUN-DART ASSEMBLY INSTRUCTIONS

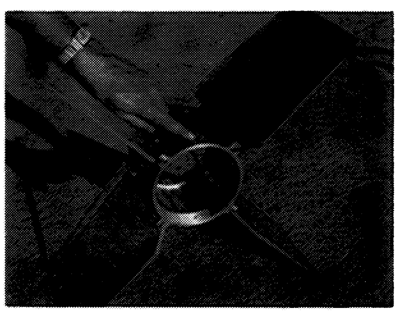
The Cajun-Dart sounding rocket system has been developed by SPACE DATA CORPORATION for use as a vehicle for making meteorological and geophysical observations of the upper atmosphere. The system employs a solid propellant booster to propel a 1-3/4 inch diameter Dart to altitudes of 90 to 95 kilometers. The rocket has a gross weight of approximately 200 pounds at launch, and an overall length (including booster) of 13 feet. Internal volume of the standard Dart configuration is slightly more than 40 cubic inches.

In operation, the booster propels the Dart to a velocity slightly over 5000 feet per second at an altitude of 7000 feet. The Dart then separates and coasts to an altitude of approximately 92 kilometers (for an 80° sea level launch). A 145 second pyrotechnic time delay contained in the tail of the Dart then ignites a boron-potassium nitrate charge which, in turn, shears the screws which attach the ogive section to the Dart and ejects the chaff from the forward end of the Dart.

The purpose of this brochure is to describe the assembly procedures for the system. A flight test report form is included on the back cover for use if the missile range is not using an equivalent form.

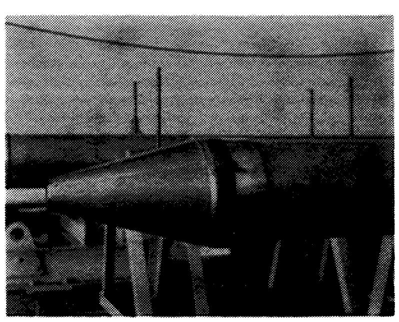


The Cajun-Dart system is normally shipped to the field in the form of the components shown at the left. Specifically, these components are the Dart assembly, Cajun motor and igniter, booster fin assembly, interstage, and forward launch lug. The first step in the launch preparation procedure is to remove the components from their respective shipping containers and visually inspect for any physical evidence of shipping damage. Check the electrical lead in the interstage for any evidence of broken leads or insulation. The Cajun motor should be placed on a suitable stand for the vehicle build-up.



Next, clean the threads on the Cajun nozzle and in the booster fin assembly with a non-ferrous brush. Loosen the two set screws in the fin assembly (see figure at left) so they will not interfere with fin installation. Apply a small amount of a suitable lubricant to the threads and screw the fin assembly onto the motor until the threads bottom. (The aft face of the fin mounting ring should be within a tenth of an inch of the nozzle exit plane when the fin assembly is bottomed.)

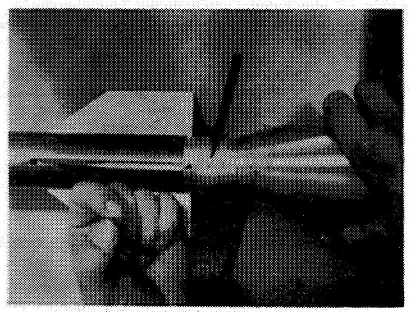
The two set screws may be tightened at this time, if desired; and must be tightened before any attempt is made to move the booster by holding on the fins. The two set screws should be tightened evely to prevent cocking the fin assembly on the motor. ONCE THESE SET SCREWS HAVE BEEN SECURELY SET IN THE NOZZLE THREADS, IT IS EXTREMELY DIFFICULT TO SUBSEQUENTLY REMOVE THE FIN ASSEMBLY.



Using the same procedures as described for installation of the fin assembly, clean the threads on the forward end of the Cajun and screw the interstage on the motor. Be sure the forward launch lug ring is in place on the interstage prior to putting the interstage on the motor. (There is no "fore" or "aft" direction associated with this launch lug.) To ensure that the interstage is securely bottomed, back the interstage off slightly just as the threads bottom, and then tighten it with a quick snap.

Rotate the forward launch lug until it is aligned with the aft lugs on the fin assembly. Note the location of the electrical leads in the interstage in relation to the forward lug position. Occasionally, the leads will be in line with the lug--as shown at the left. If this occurs, the electrical leads will interfere with the launch rail. In this event, it will be necessary to remove the two aft lugs and relocate them on the opposite side of the fin assembly.

Although it is normally advisable to delay final assembly of the Dart to the booster until the booster has been placed on the launch rail, the fit of the Dart to the booster may be checked at this point. One word of caution, however, very close tolerances are required between the mating surfaces of the Dart and the interstage--excessive fit checks of the Dart in the interstage increase the chances of damaging these surfaces.

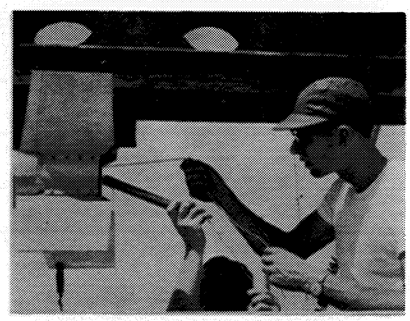


To attach the Dart to the booster, first verify that aft end of electrical leads through interstage are shorted. Check and record resistance of the Dart time delay--this resistance should be 0.75 to 1.30 ohms. Make sure mating surfaces of Dart and interstage are clean. Remove the shorting plug from the aft end of the Dart. Locate both the shear screw hole in the Dart tail just aft of the fins and matching clearance hole in the interstage. Position the Dart in line with the booster and just ahead of the interstage; rotate the Dart until the shear screw holes are in line (see figure at left). Carefully plug the Dart into the interstage until it bottoms. The shear screw hole in the Dart tail should now be located immediately behind the clearance hole in the interstage. DO NOT FORCE THE DART INTO THE INTERSTAGE if it does not slide easily; determine the source of interference.

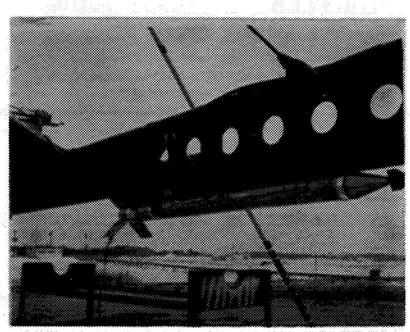
Screw the shear screw into the Dart until it is finger tight--DO NOT USE A SCREW DRIVER OR APPLY EXCESSIVE TORQUE. The protruding head of the screw should be carefully clipped off with a pair of diagonal cutters prior to launch.

Using methods which comply with the regulations and procedures of the particular launch facility, transport the booster, Dart, and igniter from the assembly area to the launch area. With the booster in a horizontal position, rotate the unit until the fore and aft launch lugs are aligned with each other, and are on top of the unit. Place the booster directly under the forward half of the launch rail. Lift the booster up to the rail, engage the fore and aft lugs, and slide the booster a few inches aft on the rail. (The booster may be safely raised and manuevered into position lifting on the fins--however, no mechanical handling equipment should contact the fins.)

Check carefully for possible interference between the launch rail and the booster. Slide the booster aft on the rail until the nozzle is located against the aft stop. (See photos below.) The booster should slide freely on the rail.



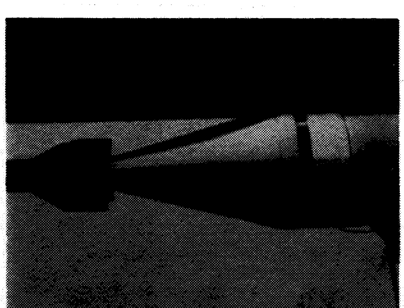
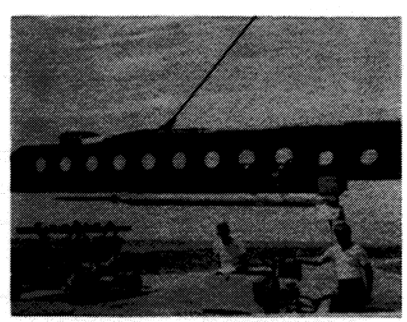
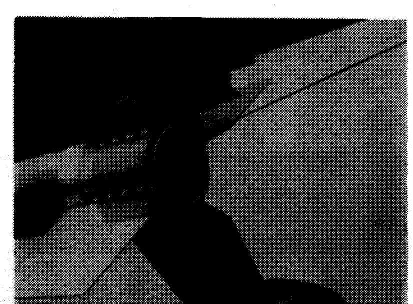
The double cotton cord which is taped to the inside of the nozzle is a single line which runs from the nozzle through the grain, through an eye-bolt attached to the forward end of the motor, and back through the grain. Make sure the cord is not twisted together inside the motor (a flashlight or other light source may be required). Check and record the resistance of the igniter--this resistance should be 0.45 to 1.00 ohms. (An Alinco Model 101-SBF igniter checker, or equivelent, should be used.) Tie one end of the cord securely to the small loop of cord on the igniter. By pulling on the other end of the cord, carefully pull the igniter through the grain to the forward end of the motor. The small red tape marker on the igniter electrical lead should be within approximately an inch of the nozzle exit when the igniter is positioned correctly. Attach the other end of the cord securely to the launch rail or other fitting which will remain fixed with respect to the rocket when the launcher is elevated. If it is necessary to remove the igniter, this may be accomplished by pulling gently on the electrical leads.



Attach the firing lead to the Dart time delay leads. (Type AN753A3 solderless connectors are provided on the lead from the interstage.) An extra two to four feet of firing lead should be lightly taped to the side of the booster, as shown at the left. Purpose of this loop is to provide power to the Dart time delay until the rocket has traveled several feet. (This assumes the Dart time delay and the booster igniter are fired simultaneously from either separate or parallel firing circuits.) A continuity check should be made to verify the circuit is satisfactory.

The booster igniter and the Dart time delay should be connected to their respective firing leads at times in the countdown and in a manner prescribed by the pad safety procedure. An MS-3106-A-20-13S type connector is provided on the igniter lead. Minimum recommended firing current for the Cajun igniter is 4.8 amps; minimum recommended firing current for the Dart time delay is 2.0 amps.

The three photos below show the forward and aft ends of the booster and the rocket system when positioned correctly on the launcher. After elevating and positioning the launcher, the rocket is ready to fire.

SPACE DATA CORPORATION FLIGHT TEST REPORT

1. Program CAJUN-DART SDC Customer MARSHALL SPACE FLIGHT CENTER - NASA

2. SDC Flight No._____ Missile Range_____ Range Operation No._____

3. Vehicle CAJUN-DART Configuration_____

4. Liftoff Date _____,196__ Time_____ LST

5. Meteorological Conditions (Clouds, Winds) Surface Temp._____°F Surface Winds_____ FPS KNOTS from_____°

Ballistic Wind_____ FPS KNOTS from_____°

6. Launcher Type_____ Settings: Effective_____°AZ _____°EL; Actual_____°AZ _____°EL

7. Motor Data

STAGE	MANUFACTURER	TYPE	SERIAL NUMBER
BOOSTER	THIOKOL	CAJUN	
DART	SPACE DATA	1.75" DIA	
IGNITER	AERO-DYNE	1a/1w CAJUN	

8. Weight and CG Data

COMPLETE STAGES	WEIGHT (pounds)	CG (inches from NEP)
BOOSTER		
DART		

RESISTANCES:

CAJUN IGNITER_____ OHMS

DART TIME DELAY_____ OHMS

9. Comments and General Results

DART CONTAINS S-BAND MYLAR CHAFF; 145 SECOND NOMINAL TIME DELAY;

CHAFF ACQUIRED AT _____ KM AT _____ SEC;

10. Preliminary Trajectory Data: Maximum Altitude_____ KFT MILES Impact Range_____ NM KFT

Time of Flight_____ SEC Payload Function Time_____ SEC

11. Personnel at Test Site_____

_____
SIGNATURE

APPENDIX C

REDUCED WINDS FROM EGLIN AFB FLIGHTS

SUMMARY OF RESULTS - CAJUN-DART WIND MEASUREMENTS EGLIN AFB, FLORIDA AUGUST 1964

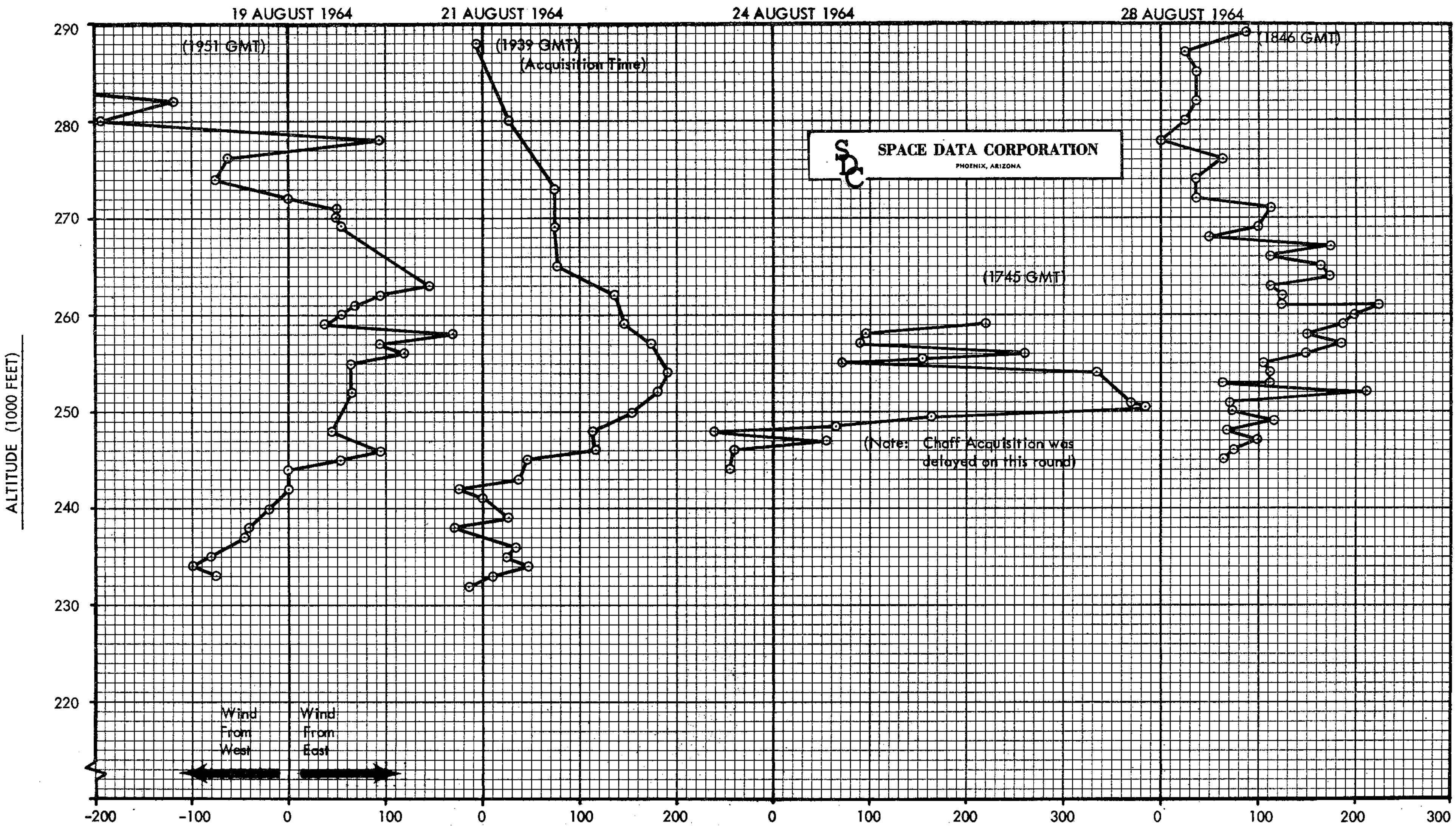


FIGURE 1 WIND VELOCITY (EAST-WEST COMPONENT) (FEET PER SECOND)

SUMMARY OF RESULTS - CAJUN-DART WIND MEASUREMENTS   EGLIN AFB, FLORIDA   AUGUST 1964

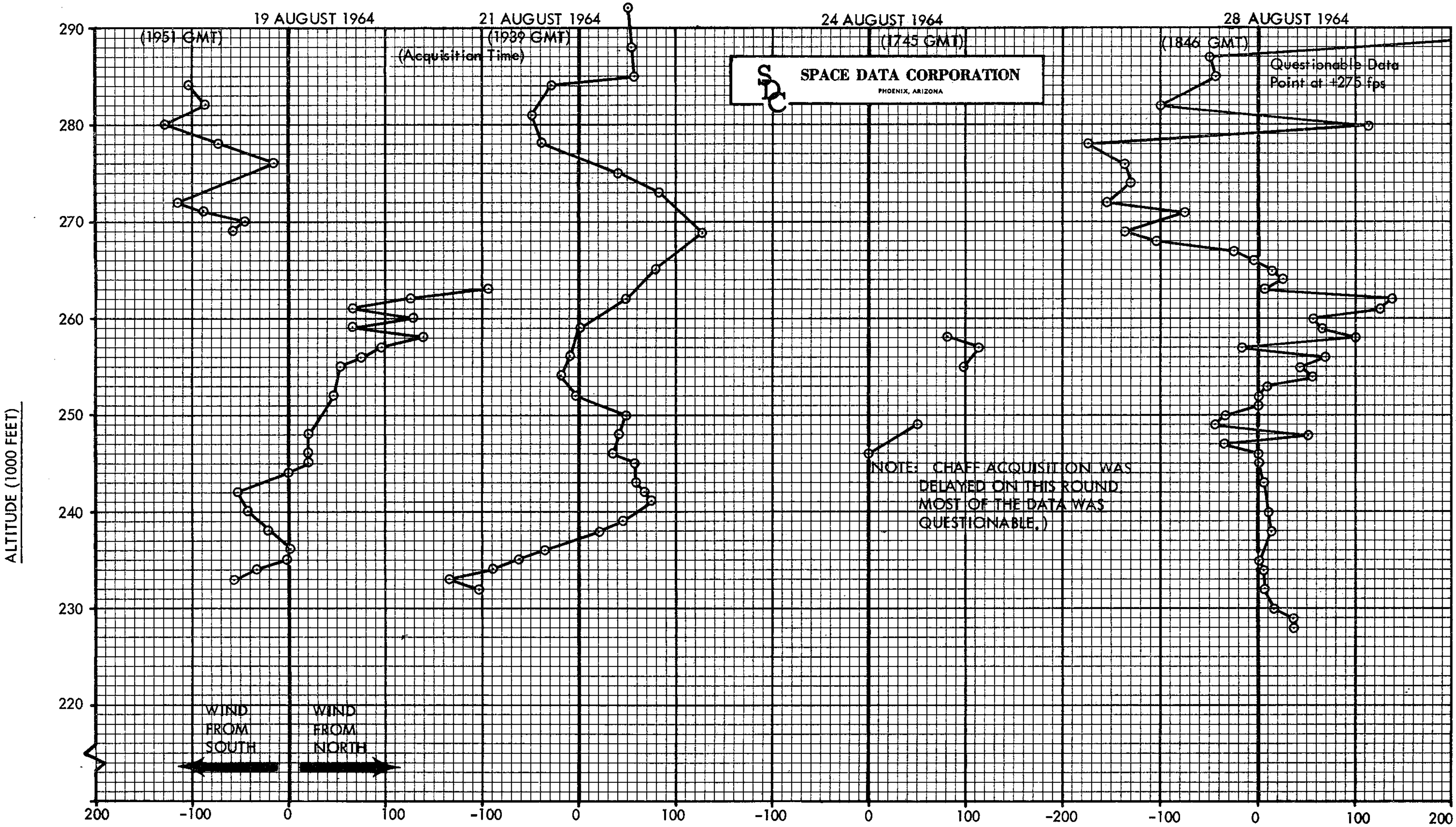


FIGURE 2 WIND VELOCITY (NORTH SOUTH COMPONENT) (FEET PER SECOND)